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Comprehensive Rating System for Net Zero Building

Neha M. Patel[1] and Dr. Digant A. Pastagia[2]
[1]Assistant Professor, Government Engineering College, Valsad
Email: nmpatel@gecv.ac.in
[2]Associate Professor, Shree Swami Atmanand Saraswati Institute of Technology, Surat
Email: digantpastagia@gmail.com

***Abstract*—The need for Net Zero Energy Buildings (NZEBs) in India becomes increasingly important due to climate change, increasing energy prices, scarcity of fossil fuels. From 2020 new buildings, including hospital and university buildings have to fulfill more strict energy requirements. Besides that, also the energy requirements for existing buildings will become stricter to realize an energy neutral built environment in 2050. Net Zero Energy Buildings are recently in trends and few buildings are already constructed in India. The assessment tools available for NZEBs are working on CRISP basis. Due to this approach developers are discourage towards development of NZEBs. Therefore, there is a need to develop an assessment tool for Net Zero Energy Buildings which provides flexible scoring system so, that developers get attracted towards planning of NZEBs. This research is focused on developing an assessment system based on fuzzy logic. For new assessment parameters will be identified based on climate zones in India. A parametric suitability survey will be carried out to check the suitability of parameters. Final outcome of the research will be in form of a flexible assessment system for NZEBs.**

***Index Terms*— Sustainable building, Net zero building, energy consumption, rating system.**

I. INTRODUCTION

In recent years there has been a worldwide effort in environmental protection and energy saving in any human activity possible. Buildings, consuming about 30-40% of all primary energy produced worldwide and being responsible for 36% of CO2 emissions, could not be missing from that effort. As the results of the energy use of the built environment, which is about 40% of the total energy consumption, become more clearly (depletion of fossil fuel and global warming), there is a demand for energy reduction and even an zero energy target.

Buildings are the primary energy consumers contributing to more than 40% of the US energy usage. According to the US Department of Energy (DoE), the heating, ventilation, and air-conditioning (HVAC) systems consume approximately 17–20% of the total energy bill of any facility or building. The gap between energy demand and energy supply be likely to a bigger issue mainly in developing countries like India and an effective way is needed to tackle that problem, another challenging part is selecting the energy efficiency resources. Indeed, NZE has the potential for a self-energy efficient building. If it applies to construction sector energy production would be both profitable and economical which would also be according to the norms and standards of environment, health, and safety.

In the last decade, energy costs have been rising, fuels are running out, and there have been global warming issues. Earth's source of fossil fuel is vanishing at a much rapid pace during the last 200 years causing high damage rates to climate change. New reserves of fossil fuels are becoming harder to find. Those that are discovered are significantly smaller than the ones that have been found in the past. Oil reserve is expected to vanish between 2050 and 2060 and so does that for gas. Coal will last longer and is expected to last till 2100.

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The concept of Net-Zero Energy Buildings (NZEB) is a solution for the reduction of GHG emissions. In the search of energy security and sustainability, NZEB can play a fundamental part. Around the world, engineers, architects and policymakers have been exploring ways to deliver highly efficient buildings whose reduced energy demand is satisfied by clean, renewable energy. Building off of the broader concept of a green or sustainable building, the concept of the "net zero building" focuses on the energy dynamics and performance of the building. cost and performance are not necessarily the main motivating factors for going to net zero energy. Projects seek to demonstrate the benefits of integrated design, long-term economic value, and healthier occupant spaces.

Buildings consume approximately 30-40% of the world's primary energy use. Considering the aggregate energy utilization all through the entire life cycle of a building, the energy execution and supply is a vital issue with regards to environmental change, shortage of vital assets and a decrease in worldwide energy utilization. Construction sector themselves offers significant natural, social, and monetary esteem. These reasons are sufficient to consider a new approach to the use of energy in the construction sector. The initial step would be creating low-energy buildings based on the ideas of energy saving and energy efficiency. Furthermore, concentrating on reducing the impact of buildings on the environment, renewable technologies would come into the concept, mitigating CO2 emissions.

II. Development of Sustainable Building

The concept of ZEB was introduced in the early 2000's and strongly emphasized over the years. Thanks to worldwide initiatives, it has rapidly spread worldwide, both in terms of concept and real applications. The sustainability of materials, processes and systems are in the process of becoming an important parameter for every human activity. In the case of buildings, the improvements still to be implemented and the expected effects on human environmental footprint are so extensive that the constraints related to sustainability are still weak. In view of future developments, the study of new processes enabling the optimization of the ratio between improvements and costs, meant in terms of sources consumption will help to create new areas of research and development. The European Commission promotes energy efficiency in buildings through the energy performance building directive (EPBD recast) where the concept of nearly zero energy building (nZEB) has been introduced as a minimum energy performance level to be reached. Three categories of interventions are necessary: passive approaches, use of efficient appliances and systems, and onsite production of renewable energy. The term of Net Zero Energy Residential building is defined as the building with zero net energy consumption i.e., the total amount of energy used by the building on annual basis is roughly equal to the total amount of renewable energy created on the site. 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.

III. Moving Towards Net Zero Building

The concept of Net-Zero Energy Buildings (NZEB) is a solution for the reduction of GHG emissions. In the search of energy security and sustainability, NZEB can play a fundamental part. Around the world, engineers, architects and policymakers have been exploring ways to deliver highly efficient buildings whose reduced energy demand is satisfied by clean, renewable energy. Building off of the broader concept of a green or sustainable building, the concept of the "net zero building" focuses on the energy dynamics and performance of the building. cost and performance are not necessarily the main motivating factors for going to net zero energy. Projects seek to demonstrate the benefits of integrated design, long-term economic value, and healthier occupant spaces. The first principle in the NZEB design focuses on reducing the amount of energy needed through passive approaches. Given the inherent needs of artificial lighting and possible heating and/or cooling, the second principle aims at implementing energy efficient systems. The renewable energy systems are needed to offset in large measure the energy demand required for lighting, heating and cooling. However, rather than performing a detailed analysis of each of the projects, a cross examination was performed instead. This procedure is expected to allow for the identification of the set of relevant NZEB design issues (combination of passive approaches (PA), energy efficient systems (EES) and renewable energy systems (RES)) which are more likely to succeed in reaching the desired energy performance. The overall concept of the net-zero design process is to minimize a building's energy demand based on building science and the creativity of architects in combination with architectural design, advanced construction details, and green technologies. With low energy demand, building systems will consume less energy and provide better physical comfort for occupants.

Spreading knowledge and engagement are ultimately the top most factors to help in reducing energy consumption, pollution and emission, and other issues such as global warming. The process starts with engagement and knowledge spreading, but it should be a closed cycle and thus needs feedback on performance. There has to be supplies that provide low and zero carbon energy and, lastly, investment. Following design standards is the first step in the design to achieve a net-zero energy building as it is important to define the sources and inputs that would be necessary to quantify the outputs and check what it needs to balance the net-energy consumed. The next step is to simulate the energy consumption using various energy modeling techniques and tools to optimize the following:

- Building orientation
- Glazing area, exposure, and shading
- Heat island reduction
- Lighting systems and capacities
- Temperatures, humidity, and relative humidity levels
- Landscaping
- Natural resources
- The overall system efficiency

IV. Net Zero Building

A zero-energy building, also known as a zero net energy (ZNE) building, net zero energy building (NZEB), or net zero building, is a building with zero net energy consumption, meaning the total amount of energy used by the building on an annual basis is roughly equal to the amount of renewable energy created on the site. These buildings do not increase the amount of greenhouse gases in the atmosphere. The wording "Net" emphasizes the energy exchange between the building and the energy infrastructure. The decrease in the building's running costs and reduction of environmental footprint are the main advantages of net zero energy building. This influences sustainability of environment as well as safe of energy. During the process of design and construction of the buildings, more investment and energy are needed to energy efficiency improvement. However, if the improvement of the energy efficiency is achieved by low-cost actions, it can lead to some important advantages. Buildings consume approximately 30-40% of the world's primary energy use. Considering the aggregate energy utilization all through the entire life cycle of a building, the energy execution and supply is a vital issue with regards to environmental change, shortage of vital assets and a decrease in worldwide energy utilization. Construction sector themselves offers significant natural, social, and monetary esteem. These reasons are sufficient to consider a new approach to the use of energy in the construction sector. The initial step would be creating low-energy buildings based on the ideas of energy saving and energy efficiency. Furthermore, concentrating on reducing the impact of buildings on the environment, renewable technologies would come into the concept, mitigating CO2 emissions.

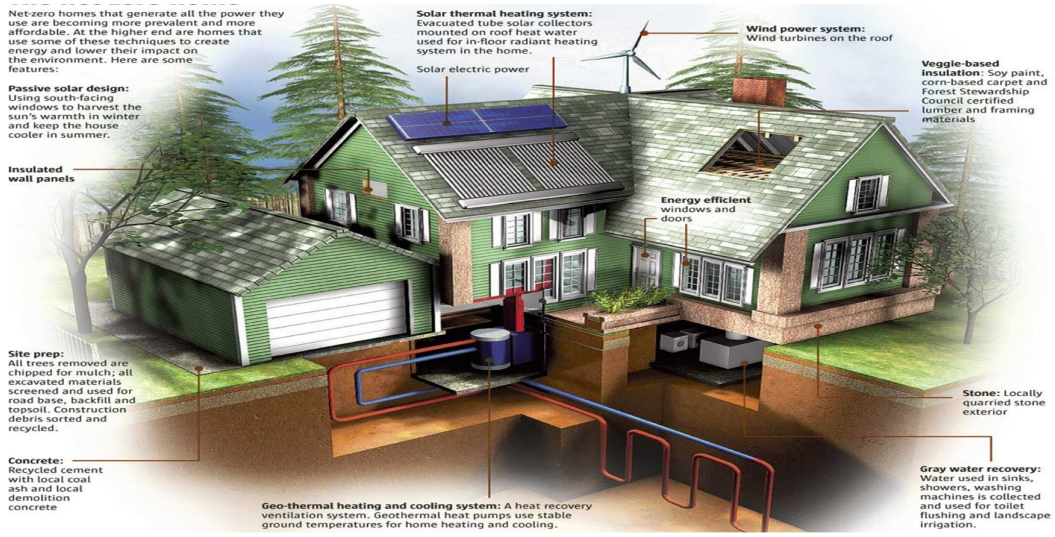

Figure 1: Features of Net zero energy building

Advantages of zero energy buildings are

- Isolation for building owners from future energy price increases.
- Increased comfort due to more uniform interior temperatures.
- Reduced requirement for energy austerity.
- Reduced total cost of ownership due to improved energy efficiency.
- Extra cost is minimized for new construction compared to an afterthought retrofit.
- Higher resale value as potential owners demand more ZEBs than available supply.

Disadvantages of zero energy buildings are

- Initial costs can be higher – effort required to understand, apply and qualify for ZEB subsidies.
- Very few designers or builders have the necessary skills or experience to build ZEBs.
- Possible declines in future utility company renewable energy costs may lessen the value of capital invested in energy efficiency.
- Challenge to recover higher initial costs on resale of building, but new energy rating systems are being introduced gradually.
- While the individual house may use an average of net zero energy over a year, it may demand energy at the time when peak demand for the grid occurs. In such a case, the capacity of the grid must still provide electricity to all loads. Therefore, a ZEB may not reduce the required power plant capacity.
- Without an optimized thermal envelope the embodied energy, heating and cooling energy and resource usage is higher than needed. ZEB by definition do not mandate a minimum heating and cooling performance level thus allowing oversized renewable energy systems to fill the energy gap.

Barriers to Net-Zero Energy Buildings

- It outlines the barriers and the key stakeholders that hold them, as organized into categories of:
- Education (related to awareness, understanding, and expressions of fear);
- Relationships (related to leadership, trust, credibility, ownership, competition, inertia, communication, contracts, covenants, liability, and experience);
- Industry infrastructure (related to training and certification, codes, standards, insurance, supply chain development, financing, marketing, and business models);
- Financial risk (related to system performance, energy pricing, value of benefits, competition, access to capital and financing, and taxes);
- Site suitability (related to permitting, zoning, land, site infrastructure, solar access, design); and Technology.

V. Existing Sustainable Rating System Worldwide

The purpose of each of the assessment method was to objectively measure the environmental performance of new and existing buildings Rating systems have evolved over the years based both on user feedback and the development of new technology to improve the environmental performance of buildings. Green rating systems started out as a voluntary measure of environmental performance. However, certification is now a mandate for buildings in many areas across the globe. Fifteen rating systems that offer certifications are currently available throughout the world and more are in development or pilot stages. Three systems are currently available for buildings outside of their home countries: BREEAM, Leadership in Energy and Environmental Design (LEED) and Green Globes, Otherwise More than 600 sustainability assessment rating systems are available now worldwide.

VI. IGBC Rating System

Indian Green Building Council launched IGBC Net Zero Energy Buildings Rating System which address energy efficiency and adoption of renewable energy. The guidelines detailed under each mandatory requirement & credit enables the design and construction of buildings of all sizes and types.

VII. GRIHA Rating System

Green Rating for Integrated Habitat Assessment has selected following criteria to assess the building sustainability. There is main four criteria and total 34 sub criteria.

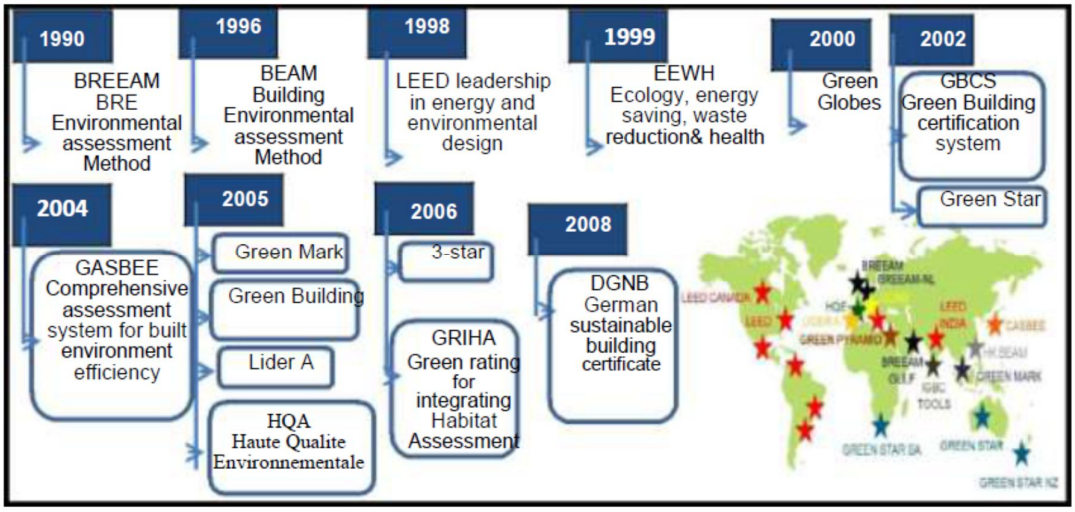

Figure 2: Existing sustainable rating system in world

TABLE I: FEATURES OF IGBC RATING SYSTEM

Objective	**To facilitate a holistic approach to make energy efficient buildings and fully powered by renewable energy sources.**	
Scope	designed for both new and existing buildings, both for air-conditioned and non-air-conditioned buildings.	
Certification Level	Net Zero Energy	National Excellence
	Net Zero Energy Platinum	Global Leadership
Submission Of Project Documentation	1) **Preliminary submittal**: submission of all documents including mandatory requirements and credits	
	2) **Final submittal:** submission of clarifications to preliminary review queries and final submittal.	

A. Resource Conservation and Efficient Utilization of Resources

Criterion 1 Site selection
Criterion 2 Preserve and protect landscape during construction
Criterion 3 Soil conservation (till post-construction)
Criterion 4 Design to include existing site features
Criterion 5 Reduce hard paving on-site and/or provide shaded hard-paved surfaces
Criterion 6 Enhance outdoor lighting system efficiency and use renewable energy system for meeting outdoor lighting requirement
Criterion 7 Plan utilities efficiently and optimize on-site circulation efficiency
Criterion 8 Provide minimum level of sanitation/safety facilities for construction workers
Criterion 9 Reduce air pollution during construction

B. Building Planning and Construction

Criterion 10 Reduce landscape water requirement
Criterion 11 Reduce the water use by the building
Criterion 12 Efficient water use during construction
Criterion 13 Optimize building design to reduce conventional energy demand
Criterion 14 Optimize energy performance of building within specified comfort limits
Criterion 15 Utilization of flyash in building structure
Criterion 16 Reduce volume and weight, and time of construction by adopting efficient technologies
Criterion 17 Use low-energy material in interiors
Criterion 18 Renewable energy utilization
Criterion 19 Renewable-energy-based hot water system

Criterion 20 Waste-water treatment
Criterion 21 Water recycle and reuse (including rainwater)
Criterion 22 Reduction in waste during construction
Criterion 23 Efficient waste segregation
Criterion 24 Storage and disposal of wastes
Criterion 25 Resource recovery from waste
Criterion 26 Use low-VOC paints/adhesives/sealants
Criterion 27 Minimize ozone depleting substances
Criterion 28 Ensure water quality
Criterion 29 Acceptable outdoor and indoor noise levels
Criterion 30 Tobacco smoke control
Criterion 31 Provide at least the minimum level of accessibility for persons with disabilities

C. Building Operation And Maintenance

Criterion 32 Energy audit and validation .
Criterion 33 Operation and maintenance

D. Innovation Points

Criterion 34 Innovation points

VIII. Importance of Comprehensive Rating System

Currently in rating system various parameters are used for credit or points based on which building is being rated. In rating system there is only one criteria is there that building have to score 75 credit points to be certified as Net zero building. So there is no any criteria or certification for buildings having credit score less than 75. hence there is a need to design comprehensive rating system which not only consider only one parameter like energy but also include parameters like water, waste, etc.

IX. Summary

There is no specific rating system has been launched for Net zero building assessment. Only IGBC has launched rating system having two levels: Net Zero Energy & Net Zero Energy Platinum. GRIHA rating system is also used as Net zero rating system though it is designed for green building rating system. The clarity in identification of the performance indicators and the scope of included items for Net zero energy building, so there is a need to develop a flexible rating system by selecting appropriate parameters based on weightage given to them. By identifying proper parameters, an assessment tool for Net zero building rating system can be introduced.

X. Limitation

Various parameters are used to rate net zero energy building but there is no thumb rule or any guidelines based on which parameter building can be rated. Hence there is limitation of Building bye laws and guidelines in assessment of Net zero building rating system.

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