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Net Zero Energy Building: A Case Study of Padra Taluka of Vadodara District

Komal J. Waldiya[1], Sumeet S. Solanki[2], Piyush D. Prajapati[3]
[1, 2, 3]*Assistant Professor, Civil Engineering, Neotech Institute of Technology, Gujarat Technological University, Gujarat, India*

Abstract: ***Global warming and climate change are raising issues during the last couple of decades. With residential and commercial buildings being the largest energy consumers, sources are being depleted at a much faster pace in the recent decades. The main aim of this project is to make the building as a net zero energy building (NZEBs). In which NZEBs design tools and applications are presented that can help designers in the commercial and residential sectors design their buildings to be NZEBs. It is much difficult to understand the overall concept of a NZEBs. As the building has significant impact on the energy use and the environment which effects on the development of the present era. The NZEBs occupants with healthy & comfortable indoor living environment and produces as much energy as it consumes on an annual base. We shall use the solar panels, solar PV system, wind energy, tidal energy, some plants to make building NZEBs & to make the building eco-friendly and energy efficient.***

Keywords: Eco-friendly building, Self- energy generating building, Energy conservation, Renewable energy resources, Sustainable development

I. INTRODUCTION

In construction of net zero energy buildings one can use the renewable resources like sun, wind, geothermal, etc. For making the self-sufficient building net zero energy building is said to be a self-sufficient building (Energy efficient building) because NZEBs use that own energy is generated per year. This is significant step that have taken and the government and administrative also have to focus on the problem as in India as the population is very large and there are more chance of effect on the environment and humanities. The aim of this research is to eliminate the future hazardous effect and also to take the benefit of the Renewable resources for construction of Net zero energy building.

II. NEED OF THE STUDY

India is the developing country, so that it consumes more energy for industrial growth and globalization which increases the energy demand of the consumers. Residential and commercial buildings consume about 40% of the total electricity used in India which have a significant impact on energy used and the environment so to eliminate the future hazardous effect and also to take the benefit of the renewable resources, the construction of Net zero energy building is said to be beneficial and recommended. Net zero energy building concept is 100% use of natural resources and zero energy consumption. So that net zero energy building is also called as a self-sufficient

III. OBJECTIVES

A. The Objectives of Study are

1) To demonstrate that an existing building is able to achieve net energy.
2) Recommendation of various climatic conditions.
3) To give possible technical solution of energy demand and energy produced at site.
4) To achieve a considerable avoidance of emission of carbon dioxide.
5) Plan a residential building.
6) Check the stability of building using STAAD PRO.
7) Determine the dead load, live load and suitable load combination of the section.
8) Calculate the annual energy use of the building using AUTODESK REVIT ARCHITECHTURE & determine the energy use intensity.
9) Reduces energy consumption.
10) Reduces greenhouse gases & global warming.
11) Reduces depended on fossil fuels.
12) Reduces ozone depletion and climate change.
13) Protect our environment for further generation.

IV. LITERATURE REVIEW

A. *Pappu Yadav et.al (2019)*

Worked on the zero-energy building uses natural energy sources to meet the energy requirement of building rain water harvesting system, HVAC system, solar system used.

B. *Rohini Brahme et.al (2009)*

Worked on modelling various technology options for different building market segments to reach net-zero energy goal. He describes the modelling of single-family residence in US southeast as a case-in-point to illustrate the most common strategies that are considered during net-zero energy.

C. *Stephen Wittkopf et.al (2008)*

BIPV Design for Singapore Zero-Energy Building research paper presents the design for Building Integrated Photovoltaic at Singapore's first Zero-Energy Building (ZEB). It introduces the general recommendations of the international integrated design workshop and the solar opportunities derived from a site analysis leading to BIPV design concept. An assessment method supported with interviews and performance simulation in preparation for the PV tender award is also presented.

D. *Elena Perlova et.al (2014)*

He identified that the acute problem of carbon dioxide emissions reduction into the atmosphere becomes more important due to the fact of the global climate change. Housing stock consumes 30 to 40% of all energy resources, according to various estimates. As the result, it is possible to get carbon dioxide atmosphere emissions reduction due to energy consumption reduction. The problem of housing stock energy efficiency improvement becomes very important.

E. *Laura Aeleneia and Helder Gonçalvesa (2013)*

The study intends to unveil a sustainable framework for sharing insights into NZEB methodology applied in a Portuguese office building, Solar XXI, based on the authors experience in the ongoing research carried out within International Energy Agency SHC Task 40 - ECBCS Annex 52,"Towards Net Zero Energy Solar Buildings".

F. *Anne-Francoise Marique et.al (2013)*

He concluded that Zero-Energy" Building (ZEB) is arousing more and more interest internationally, both in policies aiming at a more sustainable built environment (such as the European Directive PEB that will require, for example, all new buildings to be "nearly Zero-Energy" Buildings (nZEB) by 2020) and in the scientific literature. Although Zero- Energy can be considered at different scales, this approach only adopts the perspective of the individual building and neglects phenomena linked to larger scales. Therefore, this paper aims at investigating the "Zero-Energy Neighborhood" concept."

V. STUDY AREA AND DATA COLLECTION

The study area selected for this study is Padra Taluka of Vadodara district, Gujarat, India. It is located about 16 kilometers from Vadodara city. Padra is located at 22.23°N 73.08°E and it has an average elevation of 79 meters. There are about 83 villages in Padra block.

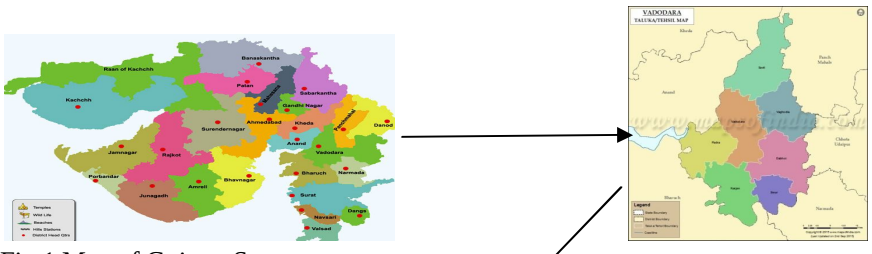

Fig.1 Map of Gujarat State

Fig.2 Map of Padra

In this study residential building is built up through net zero energy and water building concept. All the planning, designing and construction work carried out under expert civil engineer, structural engineer and construction contractor. All the construction work done by using advanced construction technologies for achieving and demonstrate that an existing building is able to achieve net energy.

In this study, during design of water storage tank for rainwater harvesting data such as number of person in household, per capita water requirement, average annual rainfall of the city, period of water scarcity, type and size of catchment, etc. are required. Data such as per capita water requirement, average annual rainfall of the city, period of water scarcity is taken from Indian Meteorological Department and Water Resources Information System (WRIS) web site, Municipal Corporation, and other Government authorities.

VI. METHODOLOGY

The first step in the data preparation is to collect the data of the existing building such as dimensions of the buildings, site area, built up area and carpet area, energy consumption and material cost of the existing building. Second step is to design and estimate cost of the material and construction of NZEBS units. During design of water storage tank for rainwater harvesting data such as number of person in household, per capita water requirement, average annual rainfall of the city, period of water scarcity, type and size of catchment, etc. are required. Data such as per capita water requirement, average annual rainfall of the city, period of water scarcity is taken from Indian Meteorological Department and Water Resources Information System (WRIS) web site, Municipal Corporation, and other Government authorities. Third step is to compare the material and construction cost of existing residential building and Net zero energy building. Output of this process lead to helps the Zero Energy Building to be cost effective after the payback period and even for the long run. Despite being a costly technique, not only it protects the environment but also saves the most valuable energies.

VII. RESULTS AND CONCLUSIONS

Estimated cost of existing residential building

Material cost	Rs.13,57,412.58
Labour cost	Rs.1,02,267.00
Completion cost	Rs.20,16,308.44

For determination of the tank capacity data such as area of the catchment (A) = 60.40 sq. m, average annual rainfall (R) = 800 mm (0.800 m), runoff coefficient (C) = 0.80 was taken and annual water harvesting capacity found out

Annual water harvesting potential = 64.40 x 0.8 x 0.8 = 41.21 cu. m = 41210 lit.

For determine the tank capacity (based on the dry period, i.e., the period between the two consecutive rainy seasons. For example, with a monsoon extending over four months, the dry season is of 245 days).

Calculate water requirement for the family= 245 x 4 x 10 = 9800 litres = 9.8 cum

Hence size of storage tank =1.5m*4m*1.7m (Size of filter tank is same as size of storage tank)

For underground sump, should same of normal storage of water. So that, underground sump contains dimensions same as 1.5m*4m*1.7m

For Monocrystalline Solar Panel

Sr. No.	Cost details	Units
1.	Solar power project capacity (kWP)	1.65
2.	Cost per kWP (₹)	Rs.41500
3.	Total project cost (₹)	Rs.65175
4.	Accelerated depreciation @ 40%	Rs.26070
5.	Corporate tax rate (%)	33%
6.	Tax saving on accelerated depreciation	Rs.8603.10
7.	Cost after tax saving	Rs.17466.90
8.	Total annual generation (kWP)	2433.75
9.	Average monthly power generation (kWP)	1475
10.	Unit rate (As per Govt. Guidelines)	Rs.7.5

11.	Project payback period (years)	1 year
	GST calculation as per Govt. guideline	
	Basic cost of the project	Rs.65175
	GST of the total project @ 8.9%	Rs.58010
	Total project costs including GST	Rs.124000

Estimated cost of net zero energy building

Material cost	Rs.1,492,060.88
Labour cost	Rs.118,400.00
Completion cost	Rs.3,900,221.81

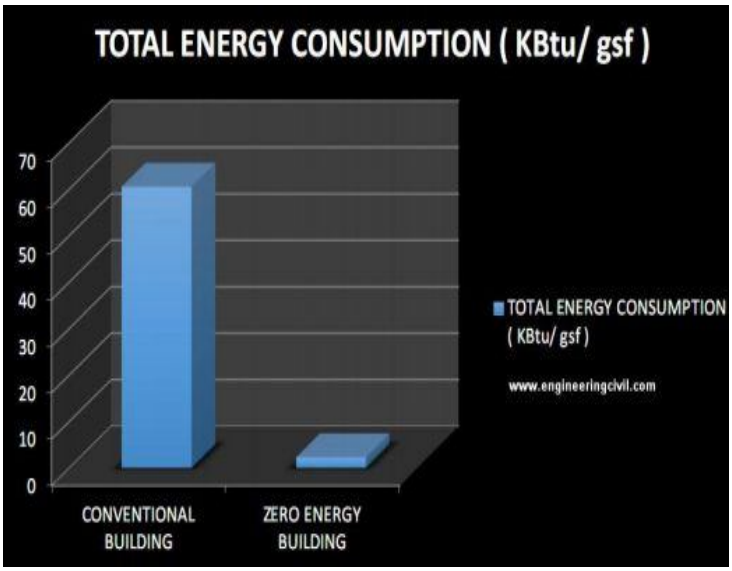

Fig.3 Total energy consumption of buildings

This helps the Zero Energy Building to be cost effective after the payback period and even for the long run. Despite being a costly technique, not only it protects the environment but also saves the most valuable energies. The installation of the solar panels initially would be costly, but in the long run the owner of the house would save money on their energy bill. More importantly, in the scarcity of natural resources we would be providing a self- sufficient, energy saving, non-polluting, Zero Energy House. The solar panels that would be installed would be on the back side of the house, which would be facing south. This would allow for the most direct sunlight to be absorbed by the panels. Also on the south side, there would be three windows that run the length of the wall, allowing the most sunlight to enter in the summer and heat the living room/kitchen area. Combined the energy efficient qualities of house with aesthetic beauty to produce a home that satisfies the customers' needs. This would attract people to buy more Zero Energy Houses which would result in less pollution and less dependence on fossil fuels.

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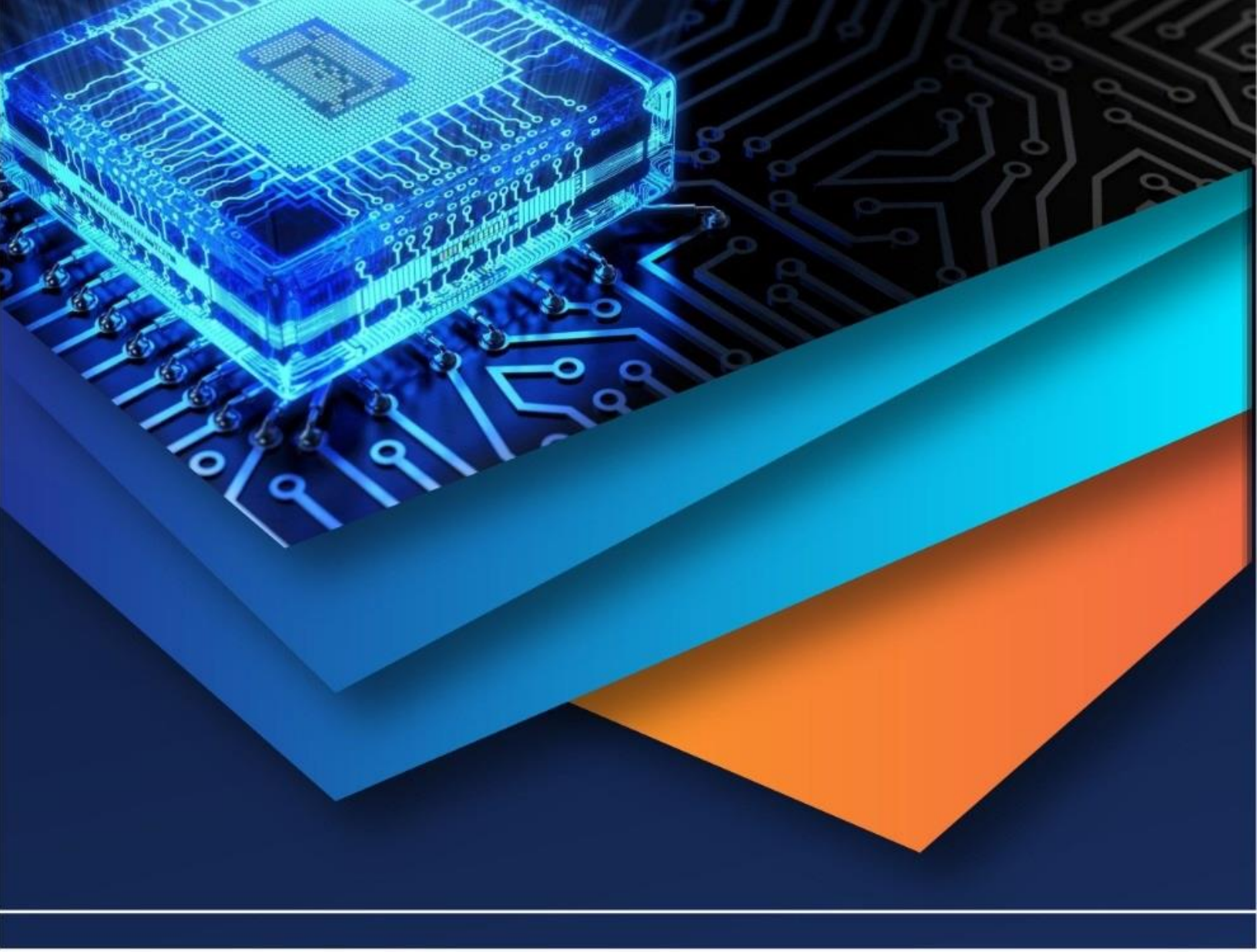

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