CSIBER INTERNATIONAL JOURNAL OF ENVIRONMENT (CIJE)

Vol. 1, Issue No. 1, March 2024

Published By :

CSIBER Press, Central Library Building,
CSIBER Campus, University Road,
Kolhapur, (MS), INDIA, 416004

Find the Journal online at
https://www.siberindia.edu.in/journals
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Published By:
CSIBER Press, Central Library Building
Chhatrapati Shahu Institute of Business Education & Research (CSIBER)
University Road, Kolhapur – 416004, Maharashtra, India

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Contact No: +91-231-2535706 / 07
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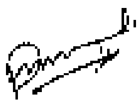
Editorial Note

CSIBER International Journal of Environment (CIJE) offers a venue where relevant interdisciplinary research, practice and case studies are recognized and evaluated. Increasingly, environmental sciences and management integrate many different scientific and professional disciplines. Thus the journal seeks to set a rigorous, credible standard for specifically interdisciplinary environmental research. CIJE is a multidisciplinary journal, publishing research on the pollution taking place in the world due to anthropogenic activities. CIJE welcomes submissions that explore environmental changes and their cause across the following disciplines like atmosphere and climate, biogeochemical dynamics, ecosystem restoration, environmental science, environmental economics & management, environmental informatics, remote sensing, environmental policy & governance, environmental systems engineering, freshwater science, interdisciplinary climate studies, land use dynamics, social-ecological urban systems, soil processes, toxicology, pollution and the environment, water and wastewater management, etc.

We invite authors to contribute original high-quality research on recent advancements and practices in Environment Management. We encourage theoretical, experimental (in the field or in the lab), and empirical contributions. The journal will continue to promote knowledge and publish outstanding quality of research so that everyone can benefit from it.

Er. D. S. Mali
Editor, CIJE



CSIBER International Journal of Environment (CIJE)

CONTENTS

Design and Analysis of Zero Energy Buildings

Mr. Gaurav R. Desai
Assistant Professor, Department of Civil Engineering,
Dr. D. Y. Patil Pratishthan's College of Engineering, Salokhenagar, Kolhapur, India

Abstract

A net zero energy building is a residential or commercial building with greatly reduced energy needs through efficiency gains such that the balance of energy needs can be supplied with renewable technologies. The acute problem of carbon dioxide emissions reduction into the atmosphere becomes more important due to the fact of global climate change. Housing stock consumes 30 to 40% of all energy resources, according to various estimates. As a 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 and hence the zero energy buildings are the need of time. The acute problem of carbon dioxide emissions reduction into the atmosphere becomes more important due to the fact of global climate change. Housing stock consumes 30 to 40% of all energy resources, according to various estimates. As a 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. Transition to low energy consumption buildings construction becomes a trend which shortly will transform into the task of Applied Research in the field of design and construction.

Keywords: Zero Energy, Day Lighting, U-Factor, Solar Energy, Rainwater Harvesting

Introduction

A zero-energy building also known as a net zero energy building, is a building with net zero energy consumption, meaning the total amount of energy used by the building on an annual basis is equal to the amount of renewable energy created on-site or in other definitions by renewable energy sources offsite, using technology such as heat pumps, high-efficiency windows and insulation, and solar panels. In India most of the energy used today is produced from fossil fuels like coal, oil, and natural gases, and a direct consequence of using these fuels is that greenhouse gases are released into the atmosphere, with one of the most significant being carbon dioxide (CO_2). The aim is to focus on the building to create a net zero by using renewable energy resources instead of non-renewable resources. We can use solar energy, wind energy, tidal energy, etc. to make the building net zero. We cannot use geothermal sources of energy at this level due to a lack of technology.In India some energy IS codes are developed for zero energy buildings, such as IGBC (Indian Green Building Council 2018), and ECBC (energy conservation building code 2017) It is an energy conservation building code for residential buildings to give a further fillip to India's energy conservation effort. It specified code compliance approaches and minimum energy performance requirements for building services and verification framework eco Niwas Samhita 2021.

Literature Review

Mr. Nitin U Thakare, Mr. Utkarsh Manwar, Mr. Shivam Tiwari, Mr. Aman Shrivastava, Mr. Tejas Mothadharim, Design of Zero Energy Residential Building, IRJET Volume: 07 Issue-09, Sep,2020.

The prior motive of this research paper is to design a Net Zero Energy Residential Building. According to the study, a major effect of building on the total worldwide energy feasting level i.e. around 40% of the total energy is expended by only buildings becoming a major main energy consumptive part of the global structure. The study is carried out based on the need for zero energy building and the method of tumbling the building energy consumption and energy protection. The study has considered HVAC systems, Rainwater harvesting systems, sewage treatment, etc.

Paul Torcellini, Shanti Pless, and Michael Deru, National Renewable Energy, Laboratory Drury Crawley, U.S. Department of Energy.

A net zero-energy building (ZEB) is a residential or commercial building with greatly reduced energy needs through efficiency gains such that the balance of energy needs can be supplied with renewable technologies. The ZEB definition can emphasize demand-side or supply strategies and whether fuel switching and conversion accounting are appropriate to meet a ZEB goal. Four well-documented definitions—net-zero site energy, net-zero source energy, net-zero energy costs, and net-zero energy emissions—are studied; pluses and minuses of each are discussed. These definitions are applied to a set of low-energy buildings for which extensive energy data are available. This study shows the design impacts of the definition used for ZEB and the large difference between definitions. It also looks at sample utility rate structures and their impact on the zero energy scenarios.

Saravan Devraj, N Kaplan , T Nagaraja, Albert M, Studies on Zero Energy Building, International Journal of Applied Engineering Research ISSN 0973-4562 Volume 13, Number 1 (2018)

In this work, a study is carried out to analyze the performance of a zero-energy building and found that it is possible to have such a building in India. The study will be carried out based on the need for zero energy building and methods of reducing the building energy consumption and energy conservation. A zero-energy building is located in BIEC, Bangalore for the study. This building is an energy-efficient building and uses renewable energy sources for heating and power generation to operate the electrical and electronic appliances.

Xenyiya Rakova, Elena Perlova, Mariia Platonova, Alexandr Gorshkov, Concept Project of Zero Energy Building, Science Direct (Elsevier)

The paper deals with the design of a building with energy consumption close to zero that is planned to be built on the Polytechnic University territory. After facility commissioning, the building will be the laboratory for energy-saving and innovative technologies in construction. During the operational phase, there will be energy monitoring of buildings, evaluation of walling's thermo-physical characteristics, and determining the actual values of energy consumption. This building will be equipped with modern measuring complexes and systems. The novelty of the project consists of an integrated approach to the house design, which will be entirely autonomous and independent from the urban networks.

Objectives:

- To provide a detailed, ambitious, clear definition and fast uptake of Zero Energy building.
- Possible technical solution of energy demand and energy production on site.
- Design a building with a zero-energy concept.
- To eliminate the necessity of active energy load on the building.

Methodology:

Passive solar design for house

Table 01: Calculation for on-grid system

Sr. No.	Description	Calculation
1.	Energy consumed by house per month is 201 units (201 kW) So, Per day	**201kW/28 = 7.17 kw**
2.	To find the requirement of the number of panels When we consider the panel of 335 watts then we require 3 panels for 1kw.	
3.	1kw panels can generate 4-5 kW/day The total number of panels required of 335 watts = 6 number.	**6 number of panels Required**
4.	Total cost required for 1 kW panels	**Rs. 73,976/-**
5.	Then the cost of the total panels For 2 kw and 6 panels	**Rs. 1,47,952/-**

Table 02: Recovery cost of installed panels.

Sr. No.	Description	Calculation
1.	Electricity cost of house per month	**Rs. 2900/-**
2.	Annual cost	**(12 x Rs. 2900) = Rs. 34800/-**
3.	Number of years required to recover the total cost of panels. Total cost required for installation Annual cost of electricity	**= Rs. 1,47,952** **Rs. 34,800**
4.	Numbers of to be required	**4 years and 3 months**

Table 03: Calculation for Off-grid system

Sr. No.	Description	Calculation
1.	Energy consumed by house per month is 201 units (201kw) So, Per day	**201 kW/28 = 7.17 kW**
2.	To find the requirement of the number of panels When we consider the panel of 335 watts then we require 3 panels for 1kw.	
3.	1kw panels can generate 4-5 kw/day The the total number of panels required of 335 watts = 6 number	**6 number of panels Required**
4.	The total cost required for 1 kw panels.	**Rs. 71,442/-**
5.	Then the cost of the total panels For 2 kw and 6 panels	**Rs. 1,42,884/-**

Table 04: Recovery cost of installed panels

Sr. No.	Description	Calculation
1.	Electricity cost of house per month	**Rs. 2900/-**
2.	Annual cost	**(12xRs. 2900) = Rs. 34800/-**
3.	Number of years to be required for recover of total cost of panels. Total cost required for installation Annual cost of electricity	**= Rs. 1,42,884** **Rs. 34,800**

4.	Numbers of to be required	**4 years and 1 month**

Table 05: Calculation for Hybrid system

Sr. No.	**Description**	**Calculation**
1.	Energy consumed by a house per month 201 units (201kw) So, Per day.	201 kW/28 = 7.17 kW
2.	To find the requirement of the number of panels When we consider the panel of 335 watts then we require 3 panels for 1kw.	
3.	1kw panels can generate 4-5 kw/day The the total number of panels required of 335 watts = 6 number	6 number of panels are required
4.	The total cost required for 1 kw panels.	Rs. 1,14,770/-
5.	Then the cost of total panels for 2 kw and 6 panels	Rs. 2,29,540/-

Table 06: Recovery cost of installed panels.

Sr. No.	**Description**	**Calculation**
1.	Electricity cost of house per month	**Rs. 2900/-**
2.	Annual cost	**(12 x Rs. 2900)** **= Rs. 34800/-**
3.	Number of years to be required for recover of total cost of panels. Total cost required for installation Annual cost of electricity	**= Rs. 2,29,540/-** **Rs. 34,800/-**
4.	Numbers of to be required	**6. years and 7 months**

Water Requirements of House

Reuse of Water

- Use of water for Gardening purposes
- Area of garden = 45m^2
- Daily use of plain water for the garden
- 1m^2 area of garden use water weekly = 25 liters

- Total quantity of water use (45 m^2 area) = 45x25 = 1125 litres per week
- Daily use of water = 1125 / 7 = 160 liters per day.
- Assume the family in the house consists of 6 persons.
- Use of quantity of water per person 135 liters per day (standard)
- X 6 = 810 litres
- **Per day use of water = 810 liters**

- **Use of daily water per person**

1. Bathing = 50 liter
2. Drinking = 5 liter
3. Cooking = 5 liter
4. Washing Clothes = 20 liter
5. Washing of House = 10 liter
6. Flushing = 25 liter
7. Washing of Utensils = 20 liter

Total water used = 135 liter

Reuse of water for washing utensils and House

- Washing of Utensils / Kitchen = 20 liter
- Washing of House = 5 liter
- Total Water reused = 25 liter

Reuse of water for daily purposes

- 1 Person = 25 litre
- For 6 people in the Building
- 25 x 6 = 150 litre
- Daily Reuse of water
- For garden = 150 litre / day
- Total water required for Garden per day = 165 liter
- So we use 15 liters of regular water for garden
- The cost of the water reduced for the garden is 90 – 95 %

U-factor or U-value

Thermal transmittance also known as the u value is the rate of transfer of heat through a structure (which can be a single material or a composite), divided by the difference in temperature across that structure. The units of measurement are **W/m^2 K**. The better the insulated structure the lower the U-value will be. When we talk about the U-value of a particular component of a building such as a wall or roof we are describing how well or how badly that component transmits the heat from the inside (usually) to the outside. On winter days or cold days, there is warmth and cozyness inside the house or building. We will be happier because of the lower U-value. It means that our wall or roof is quite good at holding up the heat getting to the outside. The component might be a homogeneous material (such as a concrete slab) or a series of materials in contact (such as a burnt brick wall) the technical name for the U-value is thermal transmittance. The U-value of building components like walls or roofs, measures the amount of energy (heat) lost through a sq. m (m^2) of a material for every degree (K) difference in temperature between inside and outside.

Units used for the calculation of the U-value are:

Energy: - flows along in watts (measured in joules)

Temperature: - temperature is measured in degrees kelvin which practically is a degree Celsius.

R-value: R-value is the capacity of an insulating material to resist heat flow. The higher the R-value, the greater the insulating power.

Units for R-value: - (m^2. K/W).

Calculation of the U-value of the components of the building

1) Wall: To find RI (the thermal resistance of the component)

RI = TiKi

Ti is the thickness of material (m)

Ki is the thermal conductivity of the material (W/m. K)

Data considered for calculation (taken from ECBC code 2017)

Ti = thickness of burnt brick + thickness of internal plastering + thickness of external plastering

Ti= 200+ 12.5+ 12.5 = 225 mm

The value of Ki is taken from ECBC code 2017 Table: 6

RI= TiKi

= 225/ 0.9

= 0.225/0.9

RI= 0.25 m^2. K/W……… Thermal resistance

Now to calculate the RT

RT =1hi + 1ho + RI (R1 +R2……)

T is the total thermal resistance m2. K/W

hi is the inside air heat transfer coefficient, W/ (m^2. K)

ho is the outside air heat transfer coefficient, W/ (m^2. K)

R1 is the thermal resistance of material 1, m^2. K/W

=19.36+ 119.86 + 0.25

RT = 0.40 m^2

To find U value: - 1RT

U =1RT

=10.40

U-value= 2.5 W/m^2. K

2) **R.C.C Roof: -** To find RI (the thermal resistance of a component)

Ti is the thickness of material (m)

Ki is the thermal conductivity of the material (W/m. K)

RI = TiKi

Data considered for calculation (taken from ECBC code 2017)

Ti = 165mm (100mm thickness of slab + 15mm off internal plastering + 40 mm thickness of expanded polystyrene of density 24 kg/m)

Ti= 0.165 m

Ki=for R.C.C Concrete = 1.58 W/m. K

For internal plastering = 0.72 W/m. K

For Expanded polystyrene = 0.035 W/m. K

The total value of KI = 2.338 W/m. K

To calculate RI

RI = TI / KI

RI =0.152.338

RI = 0.059 m^2

To calculate RT

RT =1hi + 1ho + RI (R1 +R2……)

hi is the inside air heat transfer coefficient, W/ (m^2. K)

ho is the outside air heat transfer coefficient, W/ (m^2. K)

RT=19.36+ 119.86 + 0.059

RT = 0.20 m^2. K / W

U value = 1RT

U value = 10.20

U value = 4.34 W/m^2. K

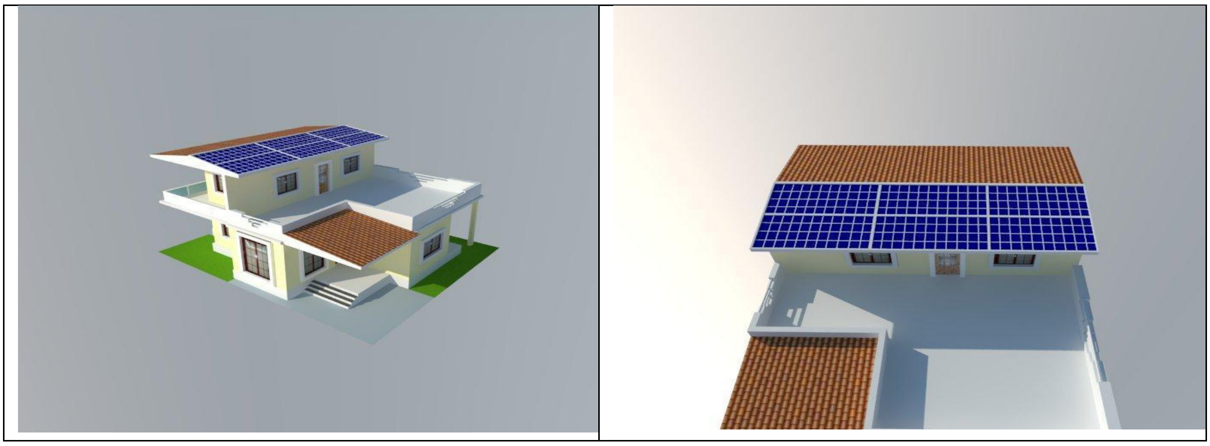


Fig 1: Proposed design of a Bungalow based on Zero Energy concept.

Conclusion

Daylighting: - When properly designed, daylighting can provide significant energy saving for building owners**.** Daylight directly affects the physiological health of building occupants and their overall well-being.

U-factor: - The results got to have a lower U-value after calculation when we compared it with the ECBC code 2017 U-values. As we know that lower U-value means a happier and healthier atmosphere inside the building.

Rainwater harvesting: - Collection of water in every possible way and every possible place it falls and store it. It can be concluded that rainwater, if conserved and utilized, can be an effective tool for replacing groundwater resources.

Passive energy: - As we observed we found that we can use renewable energy to generate energy sources by which we can save the cost of energy sources like energy bills.

Water reuse: - The pure water which is used for domestic purposes can be reused again for gardening purposes, hence we can reduce the cost of pure water by using reused water for gardening. Hence by these, we can reduce 90-95 % use of pure water.

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