Int. J. Chem. Sci.: 14(S1), 2016, 25-30
ISSN 0972-768X
www.sadgurupublications.com

CONSTRUCTION INDUSTRY STEPPING TOWARDS POSITIVE-ENERGY BUILDINGS - A REVIEW

S. P. SANGEETHA[*] and NILESH KUMAR

Department of Civil Engineering, Aarupadai Veedu Institute of Technology,
Vinayaka Missions University, Kancheepuram, CHENNAI (T. N.) INDIA

ABSTRACT

A zero-energy building, also known as a positive energy 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. Large numbers of long-term advantages are there in moving towards ZEBs, such as lower environmental impacts, better resiliency to power outages, lower operating and maintenance costs and natural disasters and improved energy security. Since such buildings are now the center of attraction, various researches are going on this area by the Engineers and Architects. This paper is a detailed review on the zero energy building (ZEB) along with the possible developments in the future for the benefit of the building designers.

Key words: Energy, Zero energy, Renewable energy, Insulation, Optimization.

INTRODUCTION

The expectations on buildings to meet higher and more complex performance requirements are increasing worldwide. They should be sustainable; use zero-net energy; create a healthy and comfortable environment for the occupants; be grid-friendly, yet economical to build and maintain. The two primary objectives of intelligent buildings are user comfort and reducing energy costs. The aim of the present paper is to present a review on the technological developments in the construction industry in moving towards ZEB. Scope and research trends in future are being discussed. Various energy-saving measures can be taken to reduce energy consumption both during design and operation phases of a building system. Most of the zero-energy buildings use the electrical grid for energy storage but some are independent of the grid. Energy is usually harvested on-site through energy producing technologies like solar and wind. The overall use of energy can be reduced by adopting efficient HVAC and lighting technologies. Day by day, the cost of traditional fossil

[*]Author for correspondence; E-mail: spsangeetha81@gmail.com

fuels increases and zero-energy goal is becoming more practical. Some of the measures include architectural considerations, construction type and material selection, use of onsite renewable energy resources, use of more energy-efficient equipment and making the operation of the equipment more efficient through advanced maintenance and control strategies.

Literature review

The attempts to ZEB dates back to 1970s and 80s' at that time, the biggest part of energy use in the buildings was mostly due to the thermal energy, the ZEB were actually zero thermal buildings. Torcellini, et al. (2006) in their research distinguished the advantages and disadvantages of ZEB The advantages include verifiable through on site measurements; Easy for the building community to understand and communicate; Better model for green Power etc.; There are not much disadvantages establishing ZEB requires skilled personnal; high intial cost of construcrion, etc.; Esbensen, et al. (1977) in their research on ZEB house in Denmark, pointed out that a Zero Energy House is dimensioned to be self-sufficient in space heating and hot water supply during normal climatic conditions in Denmark. Energy supply for the electric installations in the house was taken from the municipal mains. Parker, et al. (2001) in his research says that zero energy home generates more power than it uses, thereby reducing power demand on the utility provider. They have also concluded that during times of power outage, the home generates its own power, allowing the homeowner essential energy security. Chan & Chow (1998) has concluded in their research that an energy effective building envelope design saved as much as 35% and 47% of total and peak cooling demands, respectively.

Methodology

To calculate a building's total source energy, both imported and exported energy are multiplied by the appropriate site-to-source energy factors[8]. Building energy efficiency can be improved by implementing either active or passive energy efficient strategies such as improvements to heating, ventilation and air conditioning (HVAC) systems, electrical lighting, utilization of natural lighting, use of renewable energy, etc. Recent years have seen a renewed interest in environmental-friendly passive building energy efficiency strategies. Energy efficiency can be increased by:

Efficient building construction

Zero-energy buildings are built with significant energy-saving measures. By adopting natural methods of cooling and heating system, energy efficiency can be attained. This can be achieved by:

(a) Construction of ZEB starts with the building design. The construction Engineer should be familiar with all the steps involved in building design to arrive at net zero energy.

(b) Energy modeling softwares like Equest can be used to ensure that the zero energy goal can be achieved with this design in a highly cost-effective manner.

(c) A tight building envelope can be set by sealing the building envelope with spray foam.

(d) Using high R-value insulation that provides a continuous, unbroken layer around the building envelope.

(e) In addition, daylighting with skylights or solartubes can provide 100% of daytime illumination within the home. Nighttime illumination is done with fluorescent and LED lighting, which uses 1/3 or less power than incandescent lights, without adding unwanted heat.

(f) Miscellaneous electric loads can be reduced by choosing efficient appliances and minimizing phantom loads.

(i) Operations and maintenance

However, not much skill is required to operate or maintain ZEB a continuous maintenance without affecting the natural sources is required.

(ii) Change in occupants behaviour

The concept of ZEB can be efficiently achieved only if there is change in the occupants behavior. Energy needs should be decreased as much as possible throughout the home by:

(a) Installation of efficient lighting system like compact fluorescent lights.

(b) Turning off lights, computers, and appliances when not in use by adopting programmable thermostats and photo-sensitive outdoor light fixtures.

(c) Installation of energy generation equipment such as solar panels

(d) Using thermal mass to store excess solar energy during the winter.

Zero energy buildings in India

Residential and commercial buildings accounts for about 33% of total electricity used in India. Indira Paryawaran Bhavan is the first net zero energy building in India. It is

constructed by Central Public Works Department (CPWD) to host the Ministry of Environment and Forests offices. It is uniquely powered with solar energy by adopting Green Building concepts, such as optimisation of energy and water, water recycling, conservation of naturally shaded areas and vegetation to reduce ambient temperature, maximise energy saving and minimise operations costs[10]. This building is expected to be a trendsetter in the country and shall inspire people towards adoption of green technology. The first zero energy building is shown in Fig. 1.

Fig. 1: Indira Paryawaran Bhavan- New Delhi

The main features of this building are:

(i) The building is oriented in an East-West direction to attain effective ventilation.

(ii) The building is designed in such a way that 75% of natural daylight is utilised to reduce energy consumption.

(iii) With an Installed capacity of 930 KW peak power, the building has the largest roof top Solar system among multi storied buildings in India.

(iv) The entire building has an access friendly design for differently-abled persons.

(v) An innovative air conditioning system like Efficient Chilled Beam system of air conditioning is used, where air conditioning is done by convection currents rather than air flow through diffusers and chilled water is circulated right up to the diffuser points unlike the conventional systems.

(vi) Recycled materials were used for construction. High reflectance terrace tiles and rock wool Insulation of outer walls were used.

(vii) Door frames & shutters were made with rapidly renewable bamboo Jute composite material.

(viii) UPVC windows, with hermetically sealed double glass. Calcium Silicate ceiling tiles having high recycled content andgrass paver blocks in pavements and roads.

Besides this there are also many ZEB constructed in India like Degree College and Hill Council Complex, Leh, Airport and staff housing colony, Kargil, Visitors' Centre, Auroville, ITC Centre, Gurgaon Computer Maintenance Corporation House, Mumbai, Silent Valley, Kalasa, etc.

CONCLUSION

Zero energy buildings and the concept of smarter living offers tremendous opportunity for overhauling an average Indian's lifestyle. Moreover, zero energy buildings can be built in every climate. Reduction of energy demand is the first goal in the construction industry. As the general public becomes more aware of the benefits of such buildings, developers will get creative and find new ways to brand, market and sell ZEB, hence creating a conducive atmosphere for the sector to grow exponentially. To meet the demand of constructions materials and energy an awareness has to be created among the public about ZEB.

REFERENCES

1. Ashrae, ANSI/ASHRAE/IESNA Standard 90.1-2001 Energy Standard for Buildings Except Low-Rise Residential. Atlanta, GA: American Society of Heating, Refrigerating and Air-Conditioning Engineers (2001).

2. C. D. Barley, M. Deru, S. Pless and P. Torcellini, Procedure for Measuring and Reporting Commercial Building Energy Performance. Technical Report NREL/TP-550-38601, Golden, CO: National Renewable Energy Lab www.nrel.gov/docs/ fy06osti/ 38601.pdf (2005).

3. M. Deru and P. Torcellini, Improving Sustainability of Buildings through a Performance-Based Design Approach: Preprint. NREL Report No. CP-550-36276, World Renewable Energy Congress VIII, Denver, CO: August 29−September 3, 2004. Golden, CO: National Renewable Energy Laboratory, 8 (2004). www.nrel.gov/ docs/fy04osti/36276.pdf.

4. M. Deru and P. Torcellini, Source Energy and Emission Factors for Energy Use in Buildings. Technical Report NREL/TP-550-38617. Golden, CO: National Renewable Energy Laboratory. www.nrel.gov/docs/fy06osti/38617.pdf (2006).

5. EIA, Annual Energy Review, www.eia.doe.gov/emeu/aer/contents.html. Wash-ington, DC: U.S. Department of Energy, Energy Information Administration (2004).

6. D. S. Parker, M. Thomas and T. Merrigan, On the path to Zero Energy Homes. Produced for the U.S. Department of Energy by the National Renewable Energy Laboratory and DOE National Laboratory (2001).

7. A. Mermoud, (1996). PVSYST Version 3.3. User's Manual. Geneva, Switzerland: University of Geneva, University Center for the Study of Energy Problems. www.pvsyst.com/. Last accessed September 2005.

8. P. Torcellini, M. Deru, B. Griffith, N. Long, S. Pless, R. Judkoff and D. Crawley, Lessons Learned from Field Evaluation of Six High-Performance Buildings. Paper #358, Proceedings (CD-ROM), ACEEE Summer Study on Energy Efficiency in Buildings, August 22-27, 2004, Pacific Grove, CA. Golden, CO: National Renewable Energy Laboratory (2004) pp. 16. www.nrel.gov/docs/fy04osti/36290.pdf.

9. S. K. Sharma, Zero Energy Building Envelope Components: A Review, Int. J. Engg. Res. Applicat. (IJERA) ISSN: 2248-9622 www.ijera.com, **3(2)**, 662-675 662 (2013).

10. https://en.wikipedia.org.

Accepted : 04.05.2016