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ROLE OF NET ZERO ENERGY BUILDING IN ENERGY SECURITY

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ABSTRACT

Buildings have significant impact on energy use and the environment which in turn affects the development of country. Buildings are significant cause of climate change and energy security. In India , Buildings consumes more than 40% of country's energy and responsible for almost 40% of greenhouse gas emissions. Many initiatives taken by Government of India to increase the efficiency of buildings such as Bachat Lamp Yojna, Use of Energy Efficient Lamps. Such improvements save substantial amount of energy and reduce environmental impact. But they do not guarantee energy security and sustainability. Because, even using enrgy efficient techniques can still burn fossil fuels which then produces excessive greenhouse gases far into the future. In the pursuit of energy security and sustainability, Net Zero Energy Buildings (NZEB) can play a vital role. NZEB are so energy efficient that they can rely mainly on renewable energy generated on site. They only use nonrenewable enrgy such as utility electricity and natural gas at times of year when renewable energy does not meet the demand.This paper discusses the net zero energy building concept and briefly reviews the policy context that will make them common.

KEYWORDS: Net zero, Energy Security, Energy Efficiency, Greenhouse.

INTRODUCTION

Net Zero Energy Building is the link between energy efficient technology and renewable energy utilization. Around the world, engineers, architects and policymakers have been exploringways to deliver highly efficient buildings whose reduced energy demand issatisfied by clean, renewable energy.The concept of the "net zero building" focuseson the energy dynamics and performance of the building and as policymakersand leaders align toward the net zero concept, the focus on achieving deepenergy efficiency has centered on integrated technologies as well as waysto connect buildings to the natural environment. However, interaction with an existing energy infrastructureis decisive to balance the energy supply and demand , both in terms of quantity and the form of energy, in some cases.Seasonal storage within the building is deliberately omitted from the concept of Net Zero Energy Building.However, instead of seasonal storage , buildings can sell excess amount of energy to the nearby building with the help of smart grid system. The findings of this research are intended for, among others, commercial and public building managersand decision-makers seeking to optimize cost and resource efficiency (energy, water and waste) as partof long-term building asset management strategies.

MATERIALS AND METHODS

Concept of Net Zero Energy Building:

A Net Zero Energy Building is a building with zero net energy consumption, meaning that all the energy use by the building is totally based on renewable energy sources created on the site like solar, wind, geothermal,etc. These buildings consequently do not increase the amount of greenhouse gases in the atmosphere. Most zero net energy buildings get half or more of their energy from the grid and return the same amount of energy at other times. Buildings that produce surplus of energy over the year are called as "energy- plus buildings." The Zero Energy concept allows for a wide range of approaches due to many options for producing and conserving energy.

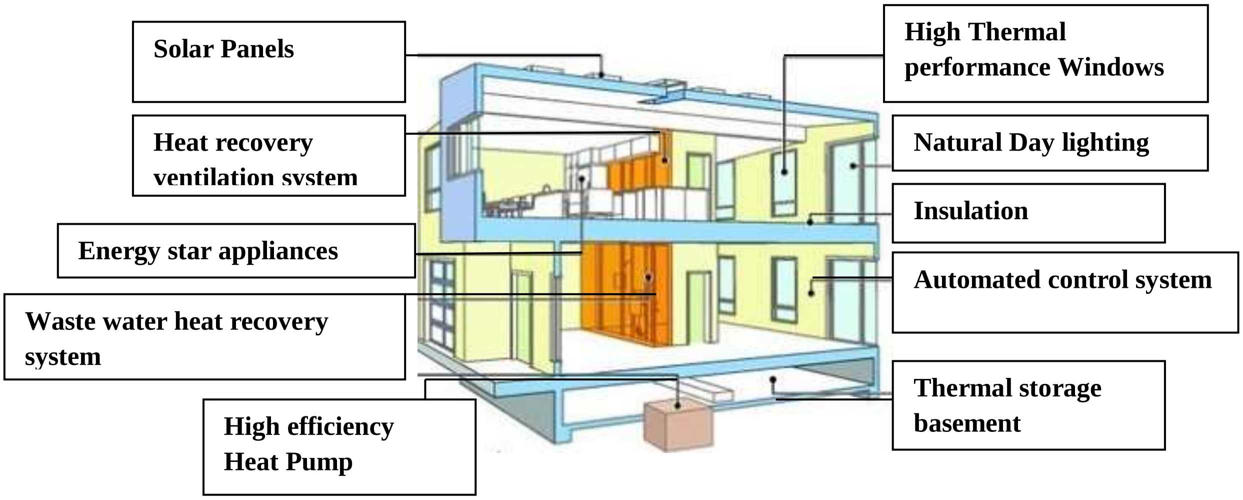

Fig.1 Concept of Net Zero Energy Building

Vision of Net Zero Energy Building:

The vision of NZEB is compelling. The net zero energy consumption principle is viewed as a means to reduce carbon emissions and reduce dependency on traditional fossil fuels. Buildingowners and tenants stand to realize attractive returnson their NZEB investments while reducing carbonfootprints. And, while today's buildings are our nation's highest energy-consuming and carbon-emmiting sector , with NZEBs, our nation can gain a network of clean domestic energy assets. The zero energy goal is becoming more practical as the costs of alternative energy technologies decrease and the costs of traditional fossil fuels increase. The development of modern zero energy buildings became possible not only through the progress made in new energy and construction technologies, but it has also been significantly improved by academic research, which collects precise energy performance data on traditional and experimental buildings and provide performance parameters for advanced computer models to predict the efficacy of engineering designs.Building design professional societies also have recognized the vision of net zero energybuildings. For example:

• ASHRAE Vision 2020 report (ASHRAE 2008) sets out requirements for developing the tools by 2020 to enable commercially viable net zero energy buildings by 2030. ASHRAE's recent conference on net zero energy buildings featured more than 25 posters(ASHRAE 2009) of NZEBs, some operating close to or at net zero and others in various stages of design or construction.

• The AIA 2030 Challenge

(AIA 2009) calls for incrementally reducing energy use, startingwith a 50% reduction over existing buildings' energy use and increasing savings up to2030, when new buildings will be carbon neutral. Architecture firms, large and small, arebeginning to make this voluntary commitment to adopt energy-saving targets in buildingdesign and implement steps to reach the carbon-neutral goal.

Methodology

The most cost effective way towards a reduction in a building's energy consumption usually occurs during the design process.[3] To achieve efficient energy use, zero energy design departs significantly from conventional construction practice. Successful zero energy building designers typically combine time tested passive solar, or artificial conditioning, principles that work with the on-site assets. Sunlight and solar heat, prevailing breezes, and the cool of the earth below a building, can provide daylighting and stable indoor temperatures with minimum mechanical means. ZEBs are normally optimized to use passive solar heat gain and shading, combined with thermal mass to stabilize diurnal temperature variations throughout the day, and in most climates are superinsulated. All the technologies needed to create zero energy buildings are available off-the-shelf today.

There are various NZEB supply options available today. These options are chatagerised as below,

a. On-site Demand Management

b. On-site supply options

c. Off-site supply options

Following figure gives some examples of NZEB supply options,

NZEB Supply options

a. On-site Demand management
- Reduce the on site energy use through energy efficient technologies
- **Ex.:** 1)Natural day light tube for lighting
  2) Passive solar heating
  3) Earth pipe for cooling and heating
  4) Natural Ventilation

b. On-site Supply options
- Use of Renewable Energy sources available within the building
- **Ex.:**1) PV system
  2) Solar hot water system
  3) Wind energy system

c. Off-site Supply options
- Use of Renewable Energy sources available off site of the building and connected to building's distribution system
- **Ex.: 1)** Biomass, wood pellets, ethanol,etc., can be imported from off site used to generate electricity on site.
  2) Purchase off site energy from certified Renewable Energy plant

Details of Supply options :
Option 1: On-Site Demand management
This option indicates that a building must reduce site energy through demand side management and energy efficient technologies. This option is considered as a prerequisite for NZEB. A well-optimized NZEB design should include energy efficiency strategies to the point that the available Renewable Energy strategies become more cost effective. Any Renewable Energy source such as passive solar space heating, solar thermal air heaters,ground-source heat pumps, and natural ventilation that cannot be commoditized, exported, andsold, are considered to be demand-side technologies and efficiency measures. Combined heatand power systems that use fossil fuels to generate heat and electricity are considered to bedemand-side technologies.[3]

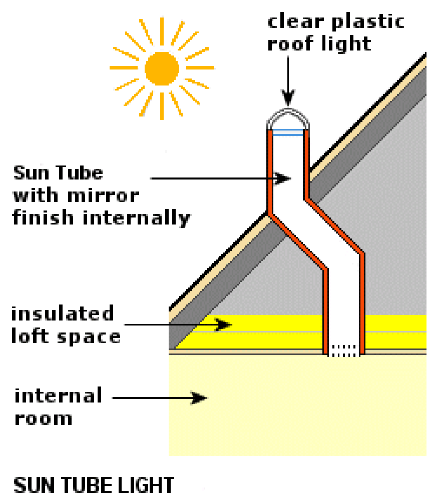

Fig.2 Natural Daylight Tube

Fig.3 Installation of Earth Tube

Option 2: On-Site supply options available within the building

This option covers all the energy sources available withing the building itself. Renewable enrgy that is generated and used within the building is directly connected to the building's distribution system. Renewable energy technology includes PV and solar thermal system which is mounted on building roof or façade. Building mounted small wind turbines also include in this option. Building-mounted RE technologies are preferable because the collection area can be guaranteed to be available over the life of the building.[3]

Option 3:Off-Site supply options available outside of the building

This option suggest Renewable sources such as wood pellets, ethanol, and biodiesel can be imported to the siteand generate electricity for building. An example of this would be woodchips imported to heat a building. Other off-site renewables covered under this option includewaste vegetable oil, biodiesel, and ethanol. Methane from human and animal waste treatmentprocesses, recovery of waste energystreams from industrial processes, or landfill gas collectionare all possible off-site RE generation options. This option is suitable for high energy use buildings such as hospitals, laboratories ans big shopping malls that do not have sufficient Renewable Energy generation capacity available within the building itself.

Case Study

Between 2008 and 2013, researchers from Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, India, North Korea, New Zealand, Norway, Portugal, Singapore, Spain, Sweden, Switzerland, United Kingdom and USA were working together in the joint research program "Towards Net Zero Energy Solar Buildings" under the umbrella of International Energy Agency (IEA)

1. Japan

After April 2011 Fukushima earthquake follow up with Fukushima Daiichi nuclear disaster, Japan experienced severe power crisis that lead the awareness of importance of energy conservation. In 2012 Ministry of Economy, Trade and Industry, Ministry of Land, Infrastructure, Transport and Tourism and Ministry of the Environment (Japan) summarized the road map for Low-carbon Society which contains the goal of ZEH and ZEB to be standard of new construction in 2020.[4]

2.Canada

On May 3, 2013, Prime Minister Harper announced funding for ecoENERGY Innovation Initiative[5] projects including a project being lead by Owens Corning entitled Integrating Renewables and Conservation Measures in a Net-Zero Energy Low-Rise Residential Subdivision.[6] This demonstration project is aimed at addressing challenges specific to production housing when building to net zero energy performance levels. The buildability Corporation[7] project management team will be working to assess and resolve challenges in relation to site planning, construction, equipment, grid connections, cost, trade capability, warranty, reliability, sales, marketing, and homebuyer information/education. Five home builders across four provinces will build at least 25 Net Zero Energy (NZE) homes by March 2016 as part of this project. The five selected builders participating in this initiative are: Mattamy

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Homes Limited (Calgary, Alberta); Construction Voyer (Laval, Quebec); Minto Communities (Ottawa, Ontario); Provident Development Inc. (Halifax, Nova Scotia); and Reid's Heritage Homes (Guelph, Ontario).In Canada the Net-Zero Energy Home Coalition[8] is an industry association promoting net-zero energy home construction and the adoption of a near net-zero energy home (nNZEH), NZEH Ready and NZEH standard.

The Canada Mortgage and Housing Corporation is sponsoring the EQuilibrium Sustainable Housing Competition[9] that will see the completion of fifteen zero-energy and near-zero-energy demonstration projects across the country starting in 2008.

The EcoTerra House in Eastman, Quebec is Canada's first nearly net-zero energy housing built through the CMHC EQuilibrium Sustainable Housing Competition.[10] The house was designed by Assoc. Prof. Dr. Masa Noguchi of the University of Melbourne for Alouette Homes and engineered by Prof. Dr. Andreas K. Athienitis of Concordia University.[11]

The EcoPlusHome in Bathurst, New Brunswick. The Eco Plus Home is a prefabricated test house built by Maple Leaf Homes and with technology from Bosch Thermotechnology.[12]

The first net-zero passive house in Northshore, Vancouver, BC, is designed by Dr. Homayoun Arbabian. The design and construction of this SuperEcoHouse is undertaken by Vancouver Green Homes LTD.

3.China

One example of the new generation of zero energy office buildings is the 71-story Pearl River Tower, which opened in 2009, as the Guangdong Company headquarters. It uses both modest energy efficiency, and a big distributed renewable energy generation from both solar and wind. Designed by Skidmore Owings Merrill LLP in Guangzhou, China,[13] the tower is receiving economic support from government subsidies that are now funding many significant conventional fossil-fuel (and nuclear energy) energy reduction efforts.

4.Denmark

Strategic Research Centre on Zero Energy Buildings was in 2009 established at Aalborg University by a grant from the Danish Council for Strategic Research (DSF), the Programme Commission for Sustainable Energy and Environment, and in cooperation with the Technical University of Denmark, Danish Technological Institute, Danfoss A/S, Velux A/S, Saint Gobain Isover A/S, and The Danish Construction Association, the section of aluminium facades. The purpose of the centre is through development of integrated, intelligent technologies for the buildings, which ensure considerable energy conservations and optimal application of renewable energy, to develop zero energy building concepts. In cooperation with the industry, the centre will create the necessary basis for a long-term sustainable development in the building sector.

5. Germany

Technische Universität Darmstadt won first place in the international zero energy design 2007 Solar Decathlon competition, with a passivhaus design (Passive house) + renewables, scoring highest in the Architecture, Lighting, and Engineering contests[14]

6.India

India's first net zero building is Indira Paryavaran Bhawan, located in New Delhi. Features include passive solar building design and other green technologies.[16]

CONCLUSION

As there is dramatic increase in global population, energy use has increased drastically. Today, buildings use approximately 40% of all energy consumed in the world. If we continue on this path of energy use in conjunction with population growth projections, with few new sources of fossil fuels,we could deplet all natural resources within few years. The buildings sector has major opportunity to reduce environmental impact by incorporating energy efficient technologies in design, construction and operation of both new and existing buildings. Net zero energy buildings are more effective and advantageous, making up applications likely to expand and permitting better and more sustainable energy systems.

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