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Integration of Onsite Renewable Energy Sources and To Validate Zero Energy Buildings

G R K D Satya Prasad, K Vijaya kumar Reddy, Saibabu Ch.

Abstract: ***At present, the buildings are account for about 40% of total global energy and also 1/3rd of GHG emissions. All buildings are having the provision of onsite renewable energy power generation, but unable to tap these resources in most of the cases. If, these resources can be tapped properly and integrated to the buildings will solve the problem of global energy shortage and also less impact on GHG emissions. In this paper, an analysis has been done by using HOMER software to estimate the capacity of onsite renewable energy sources and its integration to Zero Energy Buildings. Finally, an economical solution has been given towards integration of onsite renewable energy sources with any type of building and to make them as Zero Energy buildings.***

Index Terms**: *Homer Software, Onsite renewable energy sources, Zero Energy Buildings,***

I. INTRODUCTION

A Zero Energy Building is also known as a building with self-sustainable energy and no energy consumption from the grid or it is to be balanced from the building's energy generation. A ZEB is possible with attractive payback period and less installation costs. Hence, care has to be taken while constructing the building or renovating the building with latest technologies in passive energy technologies like HVAC optimization, daylight integration, green building materials, integrating with onsite renewable energy sources etc., ZEB can be again classified into Nearly ZEB, Surplus ZEB depending on energy shortage or surplus energy available within the building. Many constraints are to be considered and a balance has to be maintained to validate the constraints of Zero Energy building [1].

A properly balanced Zero energy building can be achieved; if a building can pass through the all the phases of passive energy features. An energy efficient building is considered mainly on electrical features along with building physical structure. A green building is mainly considered environmentally friendly equipment along with electrical and thermal loads. A sustainable building is one which is mainly concentrate on onsite power generation with renewable energy sources [2].

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*Correspondence Author(s)
G R K D Satya Prasad, Department of EEE, GIET University, Gunupur, India. Research Scholar, JNTU Kakinada.
Dr. K. Vijaya Kumar Reddy, Professor in ME Department, JNTU Hyderabad, India.
Dr. Sai Babu. Ch. Professor in EEE Department, JNTUK, Kakinada, India

II. METHODS TO PLAN ZEB

Buildings energy consumption can be assessed by Energy performance Index (EPI) which is an indicating parameter to decide the energy efficiency of the building. Energy performance is measured in terms of kWh/m2/year. The higher the value of EPI is the lesser the energy efficiency of a building. Hence, a systematic approach has to be adopted to decrease the EPI without compromising the energy comfort the resident of the building. HVAC consideration: Heating, Ventilation and Air-conditioning is the major constraint for power consumption in a building. A properly designed HVAC will decrease the power consumption of the building drastically. Day light integration: Lighting is essential in any building which is also a major source for power consumption. But Day light is properly integrated with artificial lighting; there can be drastic change in buildings energy consumption. This can be achieved by properly coordinated day light sensors, latest advanced lighting accessories. [3.4] Green building materials:
The materials used in building construction like wood, metals, sand are extracted and manufactured in around the building's premises or to that region, thereby enriching the local economy and to minimize the pollutants through transportation.

III. PROCEDURES & IMPLEMENTATIONS

Waste water technologies: Rain water harvesting integrated with building is one of the options to save the water and minimize the buildings energy consumption. Waste also purified with the process of Phytoremediation [6.7]
Water recycling is also can be done with rainwater harvesting and the entire cyclic process of harvesting of water can balance the water requirements of building. [8].
Geothermal heat pump system is another method to control the buildings HVAC load. In this system, by using the natural phenomenon of the earth system buildings room temperature can be controlled [9].

IV. SIMULATION PROCEDURE

Simulation is the process to test and validate the systems performance before to implement in real system. To validate the Zero energy building it is very difficult to analyze the parameters which are multi input and multi output parameters. Hence, to optimize the building energy parameters the constraints to be considered are selected based on various combinations. By using Building Energy Optimization programme any multi input and multi output analysis can be done easily to find the optimal cost of building.

A zero-energy building has to prove that the energy is as used to produce the same energy on annual basis. The required energy is to be met with energy generated from renewable energy sources and the electricity bill should be minimum.

In this programme, many choices have given in each category to opt for the options to design a minimum energy consumption building. Buildings energy consumption depends on site specific, buildings retrofit, user usage patterns etc.,[8]

V. SIMULATION RESULT OF A CONVENTIONAL BUILDING

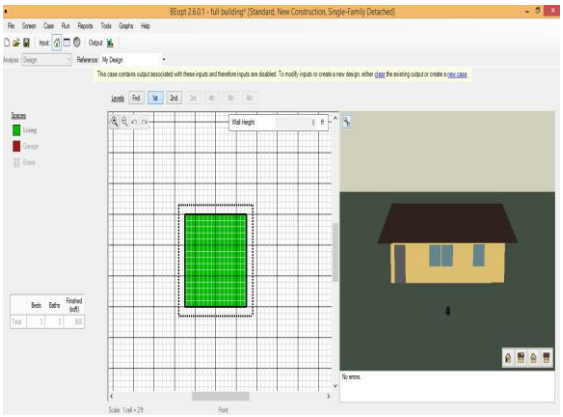

Fig. 1: layout of building input

Considerations for design parameters:

1. Wall material with different insulation materials
2. Window dimensions
3. Walls thickness with different materials
4. Angle and alignment of the building
5. Different renewable energy sources
6. Surrounding of the building
7. Electrical appliances
8. Usage and consumer behavior of the building

The above parameters can give the best combination to reduce the energy consumption of the building, so that the dependency of renewable energy sources will decrease.

Hence, proper optimization of constraints will lead to the best economical design and finally leads to a Zero Energy Building.

In BEopt simulation, these parameters will be incorporated and it will be validated with all possible combinations. An attractive payback period will allow to go for Zero Energy Building.

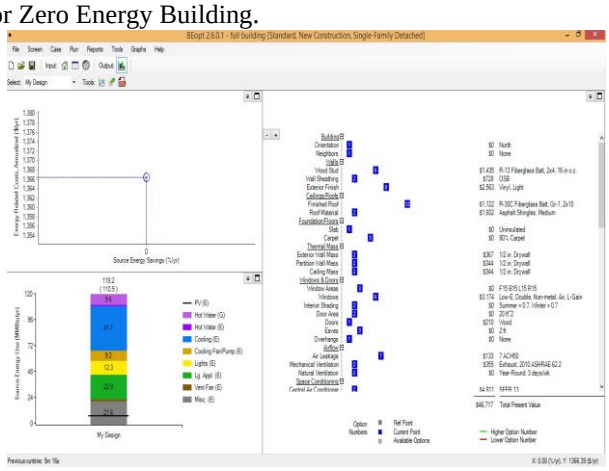

Fig. 2 Output combinations of the building

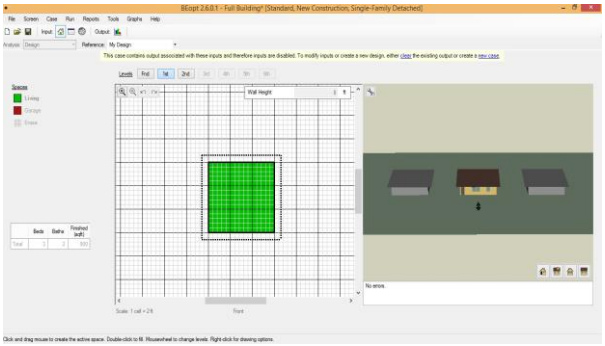

Fig. 3 : Location of the building with site specific conditions

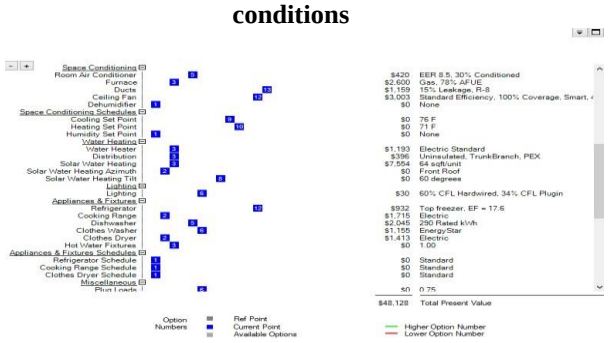

Fig. 4 : Parameters used in Simulation

To plan for a Zero Energy Building for localized energy sources, the buildings energy sources should be decreased to minimum level.

The building considered in this case study is 900 sq.ft and the total cost to constructs this building is equal to 13,,50,000 Rs/- approximately. Correspondingly the building simulation parameters are considered as shown in fig 3 and 4.

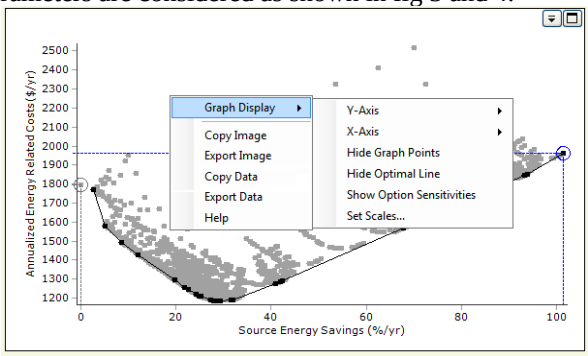

Fig.5: cost versus energy savings

The cost/energy graph can give the analysis of buildings optimal inputs and outputs.

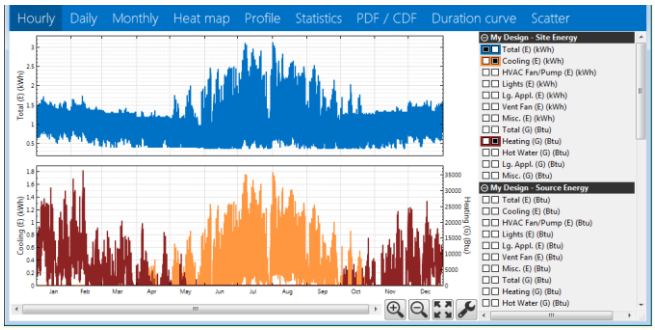

Fig. 6: Hourly data simulation results

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The hourly data is also giving the better idea about the buildings energy pattern which will gives the energy savings of the building.
The buildings annual energy saving accounts to 46,450 Rs/-
So, the payback period of the overall project will comes around 2.1 years.

Hence, a Zero Energy Building will be always beneficial if it was planned properly and integrating with onsite renewable energy sources.

Before, installing of solar or wind energy sources or calculating the capacity of the sources, enough analysis to be done to decrease the energy demand of the building. This will reduce the installation cost of the renewable energy sources.

VI. SYSTEM COMPONENTS & DESCRIPTION

Solar PV System:

The annual solar radiation at the project sire is 5.2 Kwh/m^2 per day with 2300 to 3200 sunny hours per year which is totally eco-friendly. 1KWp of solar PV generates 3.8 to 4.8 units per day. Power produced from Solar PV

$P_{pv} = I(t) \times A_{pv} \times \eta_{pv}$

$I(t)$ = Incident Solar radiation data (KW/m^2)

A_p = Efficient area of PV cell (m^2)

η_{pv} = Efficiency of PV cell

Wind Energy system

The wind turbine designed to meet the wind speeds of 8-10 m/s. The present project site is allowing the wind speed of 4-6 m/sec and permits to use wind turbine at the project site location.

$P_w = 1/2 \times \rho \times A_w \times V(t)^3 \times C_p \times \eta_w$

(ρ= density, A_w= Area swept by wind turbine,V= wind speed(m/s^2), C_p= power coefficient, η_w= wind turbine efficiency)

The Designed Solar and wind system together contribute to charge the storage batteries and helps to absorb load spikes.

System operation

Estimated load for the assumed system operation is 1000W
Period of operation is 12 hrs.
Estimated total watthour= 12×1000=12000
Solar panel exposed to sun (9am to 3pm) =8hrs
Solar panel wattage= 12000/8=1500W is used in the design and charge controller rating can be above 83amps as I=P/V (V=12v & P=1000)
I=1000/12=83Amps
So readily available charge controller in market above 83Amps can be used
Produced and consumed power should satisfy the below equation (1) & (2) for the Assumed Zero energy building at GIET
Produced and consumed power should satisfy the below equation (1) & (2) for the Assumed Zero energy building

$$\sum_{t=1}^{24} Ep(t) \times Bp(t) - Es(t) \times Sp(t) \quad \ldots\ldots\ldots\ldots\ldots (1)$$

$$E_p(t)-E_s(t)+P_{pv}(t)+P_w(t)+P_{st}(t)-P_L(t)=0 \quad \ldots\ldots\ldots\ldots (2)$$

$E_p(t)$= Energy purchased from the grid
$E_s(t)$ = Energy sold
$P_{pv}(t)$= Power produced from solar PV
$P_w(t)$ = Power produced from Wind
$P_{st}(t)$ = Charging/discharging of energy stored
$P_L(t)$ = Energy load demand
$B_p(t)$ = Buying price
$S_p(t)$ = Selling price

VII. CONCLUSION

The rising population and higher user energy demand without compromising in luxurious life styles increases the buildings energy usage rapidly. New buildings can be constructed with 60-70% less energy consumption without compromising in modern life styles and energy usage patterns.

In order to match with new protocols like clean development mechanism it is necessary to adopt the regulations to decrease the buildings energy consumption to sustain along with governments polices.

In this paper, an approach has given to adopt a zero-energy building pattern and the simulation process through BEopt 2.6. A systematic approach will give an optimum solution to construct a zero-energy building with less energy consumption along with attractive payback period.

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AUTHORS PROFILE

GRKD Satya Prasad received M.Tech in Electrical power systems from JNTU, Ananatapur. He is a research scholar in JNTU Kakinada and currently working as Associate professor in the Dept. of EEE in Gandhi Institute of Engineering and Technology University, GUNUPUR. He is a certified Energy Manager & auditor (BEE, govt. of India). He is also a member of IEEE, Life member in ISTE and SESI. He has published several papers in National and International Journals and Conferences. His area of interest is Power systems, Distributed generation, Energy conservation and renewable energy systems.

Dr. K. Vijayakumar Reddy received M. Tech in Energy Systems, Jawaharlal Nehru Technological University, Hyderabad with First Class with Distinction (1990-1992), Ph.D. in Alternate Fuel for I.C. Engine (Bio Diesel), Jawaharlal Nehru Technological University, Hyderabad (1997-2000). Presently he is working as Professor in JNTU Hyderabad. His area of Interest are Thermal Engineering, Energy Engineering, IC Engines and composite Materials.

Dr. Ch. SAI BABU received B. E from Andhra University (EEE), M. Tech in EM&ID from REC, Warangal and PhD from JNTU, Hyderabad. Currently he is working as a Professor in Dept. of EEE in JNTUCEK, Kakinada.. His area of interest are Power electronics, Distributed generation and renewable energy systems.