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# SIMULATION OF NET ZERO ENERGY BUILDING PROTOTYPE WITH RENEWABLE ENERGY INTEGRATION

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**ABSTRACT**

This paper presents the design and simulation of Net Zero Energy Building (NZEB) with the integration of renewable energy sources (RES). Due to urbanization and the increase in the living style the demand for electricity is increasing exponentially. In order to meet this demands various smart grid approaches are made out them Net-Zero Energy buildings is one of them. In this approach each consumer building is equipped with the Solar PV generation which could generate enough power to supply the buildings demand and algorithm is done so that monthly bill of the consumer is descended to almost Zero.
**Keywords**— Net Zero energy Buildings, Renewable energy resources, Solar PV

## I. INTRODUCTION

In the present scenario the total energy generated by the non-renewable energy sources like fossil fuels is almost 80% from renewable energy it is about 17% and 3% from other energy sources in order to satisfy the overall demand of the country .This large generation from fossil fuels is affecting our environment by producing harmful gases which leads to global warming. The best solution to overcome this problem is to integrate the renewable energy sources for designing the future buildings which are called Net Zero Energy Building (NZEB). The NZEB concept can be obtained by integrating the RES to grid with an intelligent controller. Fig.1.1 shows the overall block diagram of the NZEB concept containing single stage single phase solar grid connected system with the domestic loads and a controller. The solar energy is considered as a Renewable energy source and it is operated at its maximum power point by using Perturb and Observe (P and O) Maximum Power Point Tracking (MPPT) algorithm. In order to control and transfer the nature of available power generation, it is necessary to use the Power electronic interface like single phase H-Bridge inverter. The switching pulses to this inverter are provided using uni-polar sine PWM technique. The average output voltage of the inverter can be varied by varying the modulation index of the sine PWM and it is selected in such a way that the reactive power sent to the grid is zero. A grid is a constant voltage and frequency source, it is required to do synchronization before connection to the electric grid. The domestic loads are considered as pure resistive like lamp loads, it operates at a unity power factor condition. Normally the domestic loads are operated according to the requirements. So the unit consumption from the grid is increasing gradually by increasing the necessities. In order to control more power consumption from grid it is necessary to use a controller with sensors and also it is required to identify priority and unpriority loads. Now these loads are controlled with available power generation to achieve NZEB concept.

## II. WORKING PRINCIPLE

Traditionally, a small residential building consumes electrical power from utility grid. As the consumption increases, the cost of energy bill per month also increases. This will indirectly reduce the overall system efficiency and reliability. If each residential building generates electric power by Renewable Energy System (RES) such as solar and micro wind mill, it will be able to meet its own demand. Further, the reliability can increase by introducing Battery Energy Storage System (BESS). As most of the domestic loads are ac in nature, solar power needs to be convert to ac power using a Power Electronic Interfacing (PEI). Now, the generated PV power will meet the demand and will be sent to the utility. Sometimes, the generated power may be less than the demand and then the building will consume the remaining power by importing from utility. So, the net power consumption from the utility grid has to be made zero by using NZEB concept. Also money

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can be earned by exporting the excess power generated by RES at our premises [7]. This NZEB concept requires a Renewable Energy System (RES), intelligent controller, Power Electronic Interfacing (PEI), Grid and Domestic loads.

## III. METHODOLOGY

The NZEB concept can be obtained by integration of RES to grid with an intelligent controller. Fig1 shows the overall block diagram of the NZEB concept containing single stage single phase solar grid connected system with the domestic loads and a controller. The solar power is generated and fed to the grid through a power electronic interface. The domestic loads are considered and controlled to achieve the NZEB concept. The single phase H-Bridge inverter is used for which the switching pulses are generated by a sine PWM unipolar technique. The filter is used to remove the harmonics and to maintain the phase difference between the grid and inverter voltages. The P and O method of MPPT technique is used to track the maximum power under various irradiation levels. The configuration of single stage single phase grid connected solar power system with loads and controller is shown in the figure 1.

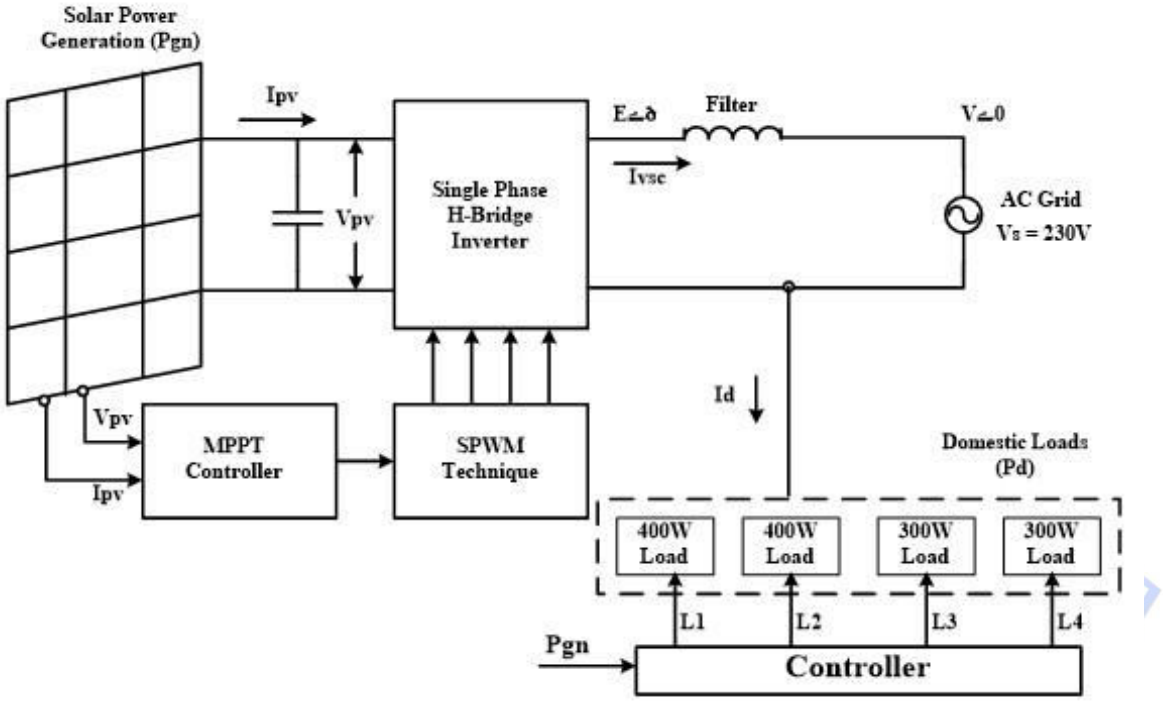


**Figure 1: Block diagram of solar grid integration**

The solar array is designed for an open circuit voltage of 548 V and a short circuit current of 3.8 A. The dc link voltage is controlled with the MPPT control technique and it is operated at the voltage of maximum power. The power generation is fed to the grid and loads through a PEI and filter. The loads are switched according to the change in power generation to get net zero concept.

The switching frequency of the inverter is considered high to reduce the switching loses and the filter size. The harmonic content in the unipolar sine PWM technique is less compared to the bipolar switching technique. Figure 2 shows the configuration of single stage single phase grid connected system. The PV panel voltage and current is fed to the MPPT controller to track the maximum power and the voltage at which the maximum power obtained is compared with the PV panel voltage. The difference in the reference and panel voltage is passed through the PI controller to reduce its error. The output of the PI controller is constant and considered as load angle (Phase angle between the grid and inverter voltage).

The Phase Locked Loop (PLL) is used to sense the grid frequency for successful grid synchronization. The phase of the sine waveform in sine PWM is varied proportionally with the change in power generation.

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At unity power factor condition, the reactive power sent to the grid is maintained at zero by choosing the appropriate modulation index value.

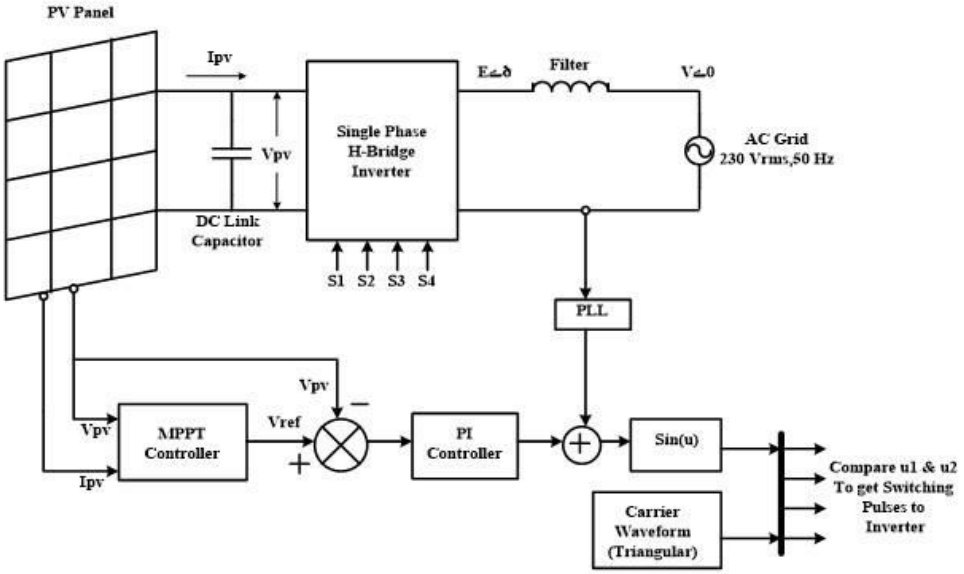


**Figure 2: Configuration of single stage single phase grid connected solar power generation**

The Phase Locked Loop (PLL) is used to sense the grid frequency for successful grid synchronization. The phase of the sine waveform in sine PWM is varied proportionally with the change in power generation. At unity power factor condition, the reactive power sent to the grid is maintained at zero by choosing the appropriate modulation index value.

## IV. SIMULATION & RESULTS

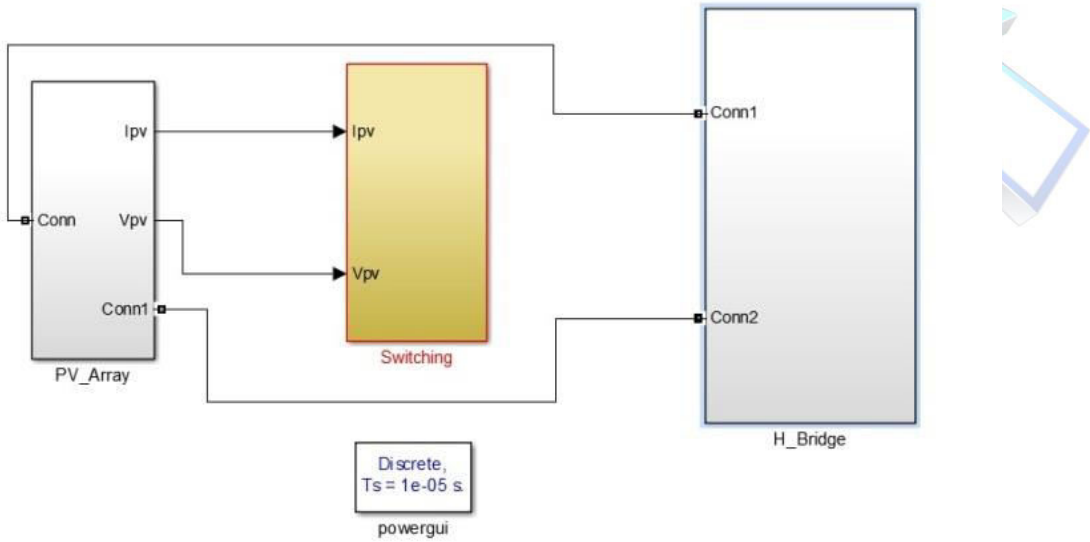


**Figure 3: Simulink model of the system**

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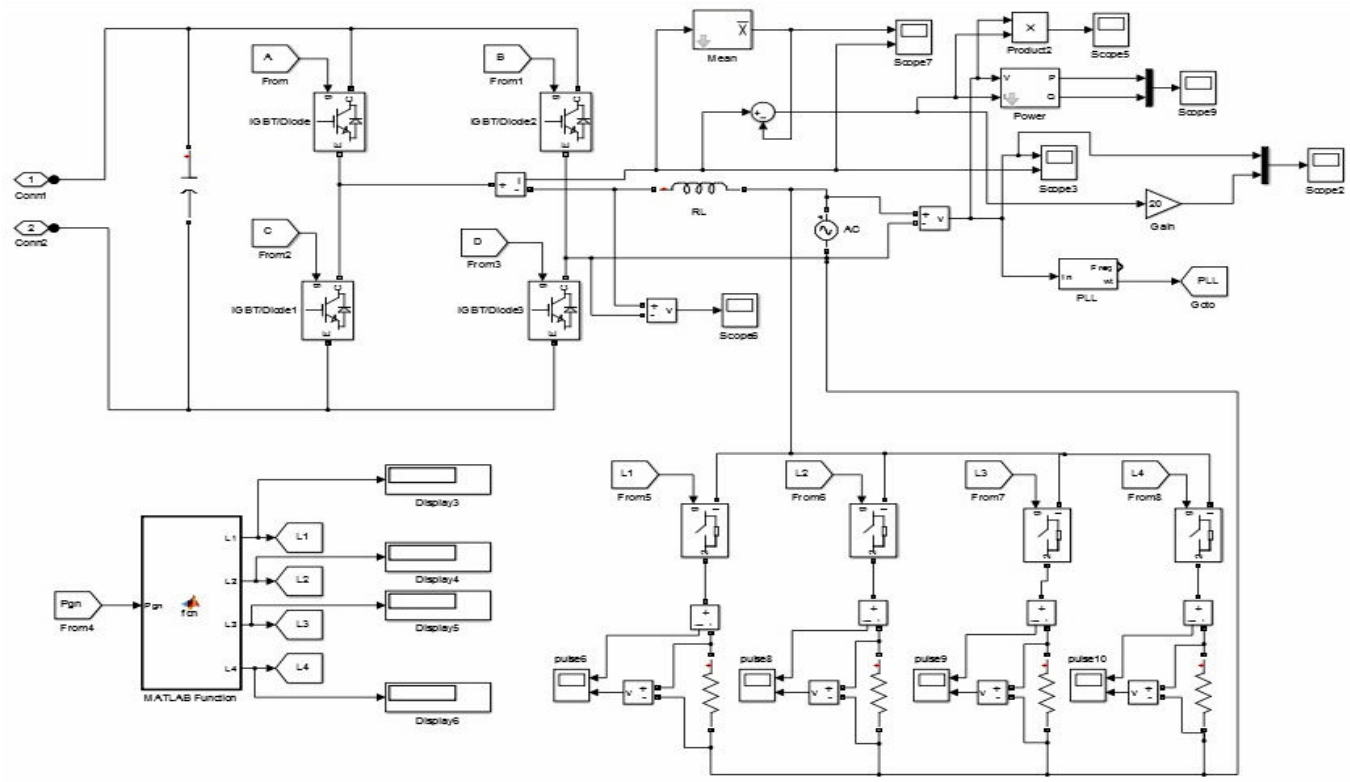


**Figure 4: Subsystem of the system**

The net power is the difference of power generation to the power demand. Fig. 5 shows the net amount of power is supplied to the electric grid over a given period of time. At 1000 W/m2 irradiation, the generated power is 1550 W. So all the electrical loads (400W, 400W, 300W, 300W) are switched ON and the net power achieved is 150W. Similarly for every change in irradiation, the corresponding loads are controlled to achieve the NZEB concept.

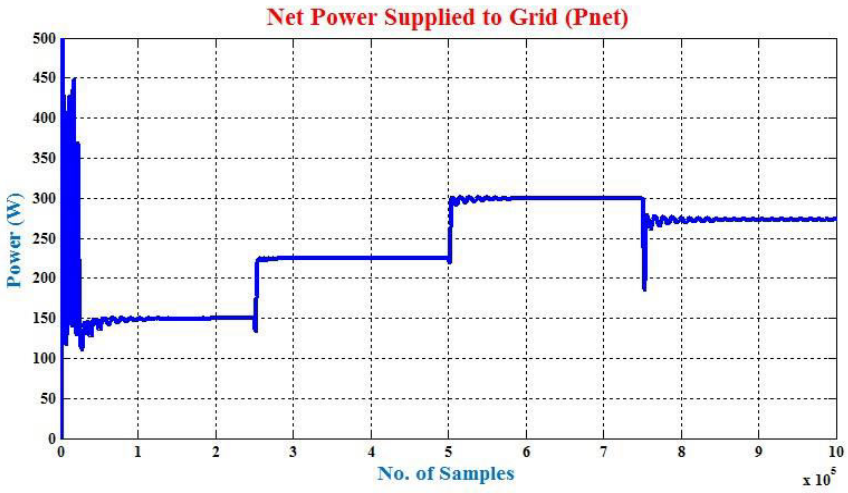


**Figure 5: Net power supplied to grid**

The positive net power indicates that the loads are always maintained below the amount of power generation.So that the consumer can sell the net amount of power to the electric grid. Fig.6 and 7 shows the grid voltage and the load current at unity power factor condition under various irradiation levels

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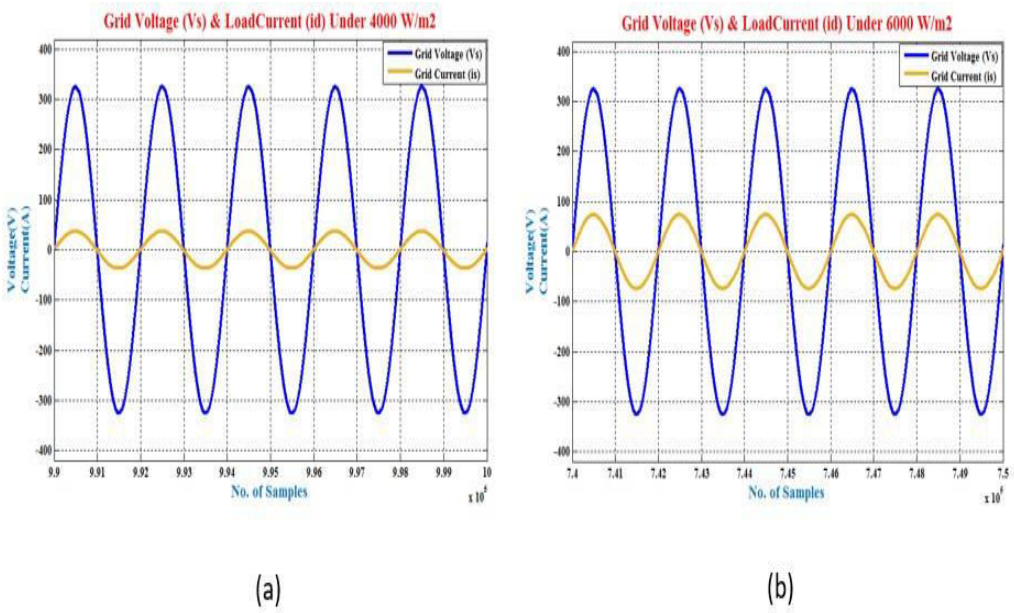
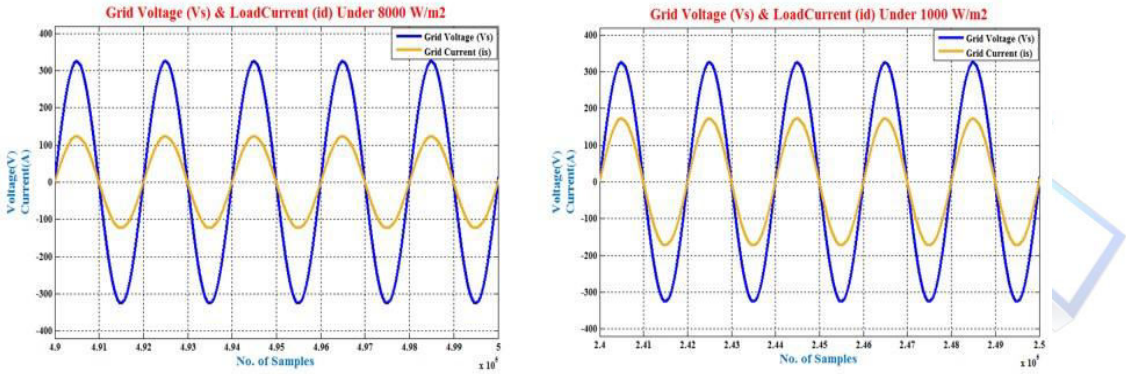



(a) (b)

**Figure 6. (a) Grid voltage and Load current at 400 W/m2, (b) Grid voltage and Load current at 600 W/m2**




(a) (b)

**Figure 7.(a) Grid voltage and Load current at 800 W/m2, (b) Grid voltage and Load current at 1000 W/m2 grid.**

## V. CONCLUSION & FUTURE WORK

With the simulation result we can obtain the best possible ways of energy management which focused on to enable a NZEB technology subsequently, monitoring and controlling with an intelligent controller based building energy management system .The proposed paper shall implement a system consisting of solar PV connected to the grid via a converter. The paper shall analyze the best techniques by which this building can be made a NZEB.

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