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DESIGNING AND PERFORMANCE ANALYSIS OF HYBRID INVERTER

SHIVAM KUMAR* YASH SRIVASTAVA**RAVI GUPTA***POOJA SINGH****

ABSTRACT

Hybrid inverters are used to perform in multimode operation. A micro grid system consisting of different types of renewable energy sources are used to get uninterrupted power supply with the help of hybrid inverter. In this paper we have proposed a design of micro grid having hybrid inverter using MATLAB Simulink.

A 250-kW grid-connected photovoltaic (PV) plant systems have been installed at the Ministry of Electricity in Baghdad and penetrated to the Iraqi national grid since November 2017. Solar PV energy is one of the most promising renewable resources that use the abundant and free energy from the sun having clean, inexhaustible and environmentfriendly cyclic operations. However, the intermittent nature of the output power of PV systems reduces their reliability in providing continuous power to customers. Solar PV energy can be used mainly in standalone (off-grid) and grid connected system. A standalone solar PV cannot provide a continuous supply of energy due to seasonal and periodic variations. Therefore, in order to satisfy consumer load demand, grid connected PV energy systems that combine solar energy and other conventional conversion units are becoming more popular in recent years. But, the fluctuations in the PV output power with climatic conditions might lead to undesirable performance of the electric network in grid connected system.

1 INTRODUCTION

Conventional power sources are reduced day by day. Research is going on to increase the use of renewable energy sources. Hybrid inverters are needed to get uninterrupted power supply from the weather dependent renewable energy sources. A hybrid inverter system can be used in both high power cut area or areas. There is rare or less power cut in rural areas. Under normal operating conditions it can supply power to the home, charge the batteries and excess power can fed into the grid. In case of a power cut the unit will automatically switch on the battery, supply and continue independently from the power grid. They save money and easy to install and maintain.

A hybrid inverter is a type of inverter that combines the functions of a traditional grid-tied inverter with those of a battery-based inverter. It can convert DC power from solar panels or other renewable sources into AC power for use in your home or business. In addition, a hybrid inverter can also charge and discharge a battery bank, allowing you to store excess solar energy for use during times when there is no sunlight or during a power outage.

Hybrid inverters are becoming increasingly popular because they provide greater flexibility and control over energy usage. By storing excess energy in a battery bank, you can reduce your dependence on the grid and use your renewable energy more effectively. You can also use the

battery bank as a backup power source in case of a blackout or other power outage.

Some hybrid inverters also come with built-in energy management systems, which allow you to monitor and optimize your energy usage. They can help you determine the best times to use your appliances, and even automatically turn them off when you are not using them. This can help you save money on your energy bills and reduce your carbon footprint.

2 METHODOLOGY

The principle of a hybrid inverter is to manage and control the flow of energy from multiple sources, including solar panels, batteries, and the grid. The hybrid inverter is responsible for converting the DC power generated by the solar panels into AC power that can be used to power homes and businesses. It also manages the flow of energy to and from the batteries, ensuring that they are charged when there is excess solar energy and providing power when the solar panels are not generating enough energy.

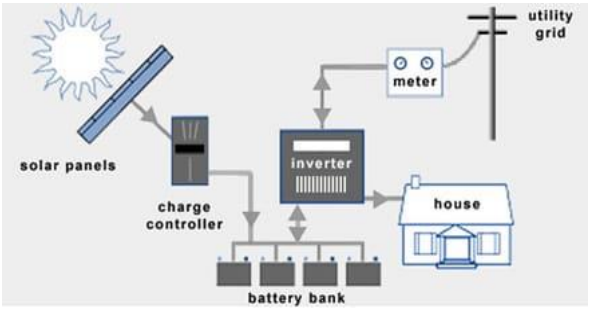

Figure 1.Block diagram of hybrid inverter

To understand how a hybrid solar inverter works, it is first necessary to understand how a solar inverter works. It is an important part of the solar system. Hybrid solar inverter So convert energy produced by photovoltaic panels into a form that can be used in the home. Photovoltaic panels or solar panels of a solar system capture solar energy. Sunlight is made up of small packets of energy called photons. Photovoltaic panels absorb these photons and convert the light energy into electricity. The materials in photovoltaic panels have electrons that can be detached from their outer shells when photons strike them. Once electron photons knock electrons out of their shells, they become free. The electric field then pulls these free electrons in the desired direction. This is how it generates electricity. However, this electricity is direct current. Now, the job of the inverter is to convert this electrical energy into a usable form. The hybrid inverter also has a range of control and monitoring functions. It can track the amount of energy generated by the solar panels, the amount of energy stored in the batteries, and the amount of energy being used by homes and businesses. This information can be used to optimize energy usage and reduce costs.

Overall, the principle of a hybrid inverter is to provide a flexible and efficient solution for managing multiple energy sources and ensuring a reliable supply of power. By intelligently managing the flow of energy between solar panels, batteries, and the grid, hybrid inverters can help reduce energy costs, increase energy independence, and provide backup power during outages.

In addition to this, the hybrid solar inverter has a backup system. Usually, this is a battery. It helps the inverter store energy in the battery as long as additional energy is available. It can use this energy when needed. Therefore, it can provide energy in an emergency.

Hybrid solar inverters can also combine solar and wind energy. Also, it can have a backup battery. It manages electricity and switches to solar, wind or batteries when needed.

3 SYSTEM DESIGN

3.1 Modelling of solar cell and module

The short-circuit current (Is) from a cell is nearly proportional to the illumination, while the open-

circuit voltage (Voc) may drop only 10% with an 80% drop in illumination. The important result of these two effects is that the power of a PV cell decreases when light intensity decreases and/or temperature increases. The amount of power generated by a PV cell depends on the operating voltage of the PV cell array. It's V-I and V-P characteristic curves specify a unique operating point at which maximum possible power is delivered. The point at which the PV operates at highest efficiency is called the maximum power point (MPP). The light generated current (Ipv.) is the function of solar irradiance and environmental temperature. The little impact has also been shown by the wind speed. Irradiance has direct relation while working temperature has inverse relation to the Ipv.

In gird connected PV system, the output from the PV system is connected to utility grid by means of PV grid tied inverter. Unlike off grid system, there is no need of batteries and charge controllers but the grid tied inverter should have special functioning capability such as anti-islanding, grid synchronization etc.

The fluctuating behaviour of PV output with environmental condition may degrade the power quality of inverter output which may cause to degrade the performance of utility and the consumer electrical appliances. So, to study the performance of PV grid connected system, 250KW Grid Connected PV system is modeled using MATLAB/Simulink and detail study has been carried out in this work.

3.2 Modelling of MPPT system algorithms

Maximum Power Point Tracker (MPPT) is used to operate the module at the peak power point so that the maximum power can be delivered to the load under varying temperature and irradiance conditions. A DC-to-DC converter serves the purpose of transferring maximum power from the solar PV module to the load by changing the duty cycle of it and load impedance as seen by the source is varied and matched at the point of the peak power with the source so as to transfer the maximum power.

Among various algorithms, Perturb and Observe (P&O) algorithm is used in this work for the MPP tracking. A slight perturbation is introduced to the system, due to this perturbation, the power of the module changes. If the power increases due to the perturbation, then the perturbation is continued in that direction. After the peak power is reached the power at the next instant decreases and hence after that the perturbation reverses. The MATLAB/Simulink model has shown in Fig. no 3.

3.3 Requirements of grid connection system

Power quality, protection coordination and grid synchronization are the major issues to be concern over the grid connection of solar PV system. Harmonics, voltage regulation, power factor, EMI and DC current injection are the main power quality issues that may cause adverse effects like additional heating, reduction of transmission system efficiency, overheating of distribution transformers, malfunctioning of electronic equipment etc. in gird connected system if not properly of the full rated output current at the point of DR connection as per IEEE standards. addressed. According to IEEE1547 standard, allowable current THD is 5% (Even harmonics are limited to 25% of the odd harmonic limits), 2 % for voltage THD and 1% for individual voltage harmonics in Distributive Resource (DR) connected to area Electric Power System (EPS). DC current injection shall not be greater than 0.5%

The complete model for gird connection of 250kw PV system has shown in figure no 2.

3.4 Block Diagram Of 250KW Grid Connected System

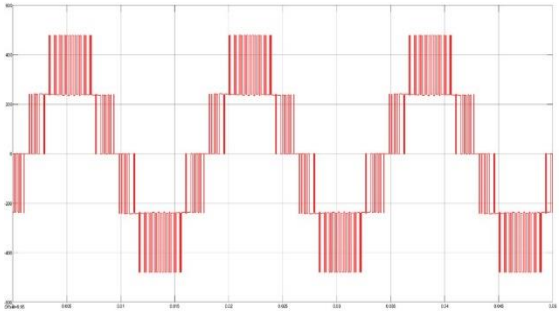

Figure 2.Simulation Block Diagram

3.5 Simulation Result

3.5.1 Output Waveform from PV Array IV and PV Curve

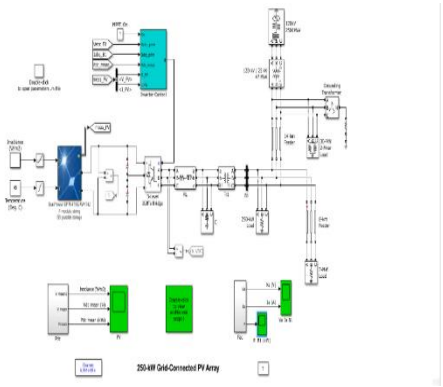

Figure 3. PV Array IV and PV Curve

3.5.2 Waveform of the Irradiance, Vdc mean and Pdc mean

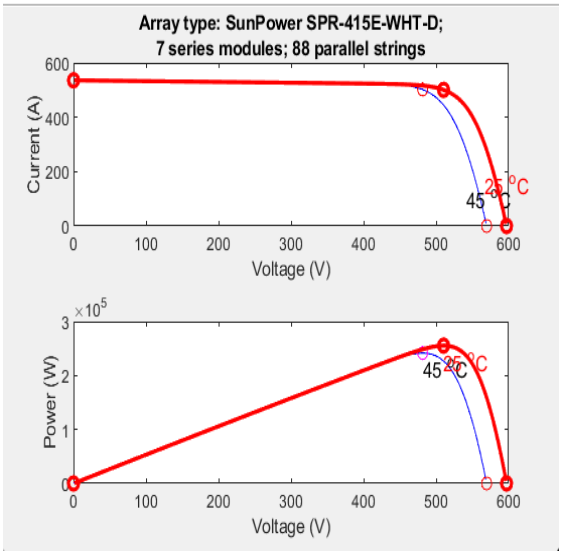

Figure 4.Irradiance, Vdc mean and Pdc mean

3.5.3 Waveform of the just before INVERTER Circuit

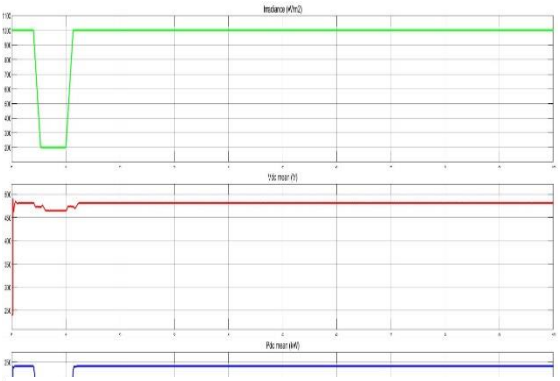

Figure 5.Waveform of the just before INVERTER Circuit

3.5.4 Output Waveform of AC Voltage and Current after filter

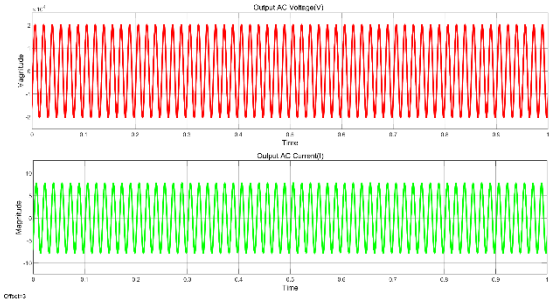

Figure 6.Output Waveform of AC Voltage and Current after filter

3.5.5 Waveform of Output AC Power

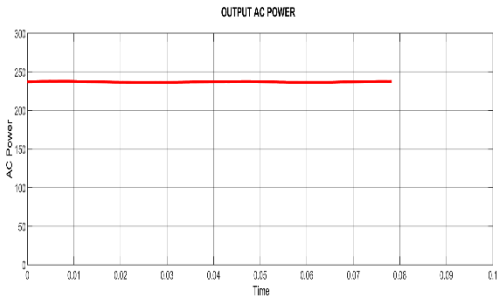

Figure 7.Output AC Power

4 LITERATURE SURVEY

When an AC power goes off, the storage supplied by the battery should be maintained the batteries would be precisely charged by solar AC grid source on night-time or muddy weather when source light is obtainable in any case of AC line status would be charged battery [1]. Introduce solar in addition to wind hybrid energy system also the main supply. The design allows the three sources energy to the battery too supply the load individually on concurrent depending on the accessibility of energy. This will be applicable in hill/ village areas. A hybrid design of battery system and its implementation is the topic of the paper [2]. The paper designed in this way that we get the battery of the limitation of solar energy. Charging system of solar battery has an inverter fueled by 12v battery and the inverter create up to 230v AC. Thus, batteries are charged from two sources that is main power and solar energy. If main power supply is available then the relay switches to main power supply for applying the load [3]. With the help of the solar battery charging system has an inverter that is fueled by a 12v battery. It helps generate 110v AC driven circuitry and a massive load transformer. The solar panel can use as a isolated system or as a large solar system connected to a power grid [4]. The earth receives the 84 terawatt of power and absorbs only 12 terawatts. PCS can able to work in grid commended mode in regular operation and also can charge the batteries [5]. It is able to operate standard mode during grid side faults and deliver power to local loads with the help of controlled in loop relation in result, the posed will be balanced [6]. A bidirectional diode converter connective PV diode which controls the battery state and optimize the PV pole. By this process the inverter efficiency in battery will improve [7]. The hybrid inverter is mainly runs on wind turbine and solar energy is able to feed a certain amount of power to load under all conditions because it can be used as an uninterruptible power source and different modes of operation like solar, wind, hybrid and battery power transfer takes place. If solar mode and wind mode does not work then hybrid mode will work after we enable it. The paper [8] based on the design of solar inverter which is need to run AC loads mostly used as flammable motive. The power output of the plotted inverter is 100W, input voltage is 12V, output is 220V, and 50Hz square wave output. The paper [9] design and execution of 1Kw SPWM form inverter to convert the applied DC voltage from photovoltaic array in pure sinusoidal AC voltage and frequency standard grid output that is 220V and 50Hz.The essence of their research work is use of an economical and advanced 16bit PIC micro controller to generate the popular SPWM with very high carrier frequency to control the inverter circuit. The paper [10] presents grid connected PV inverter has a control strategy. This system study is ready under LVRT condition. The plan is built on current loop under single axis along with rotating co-ordinate system. Grid connected PV system own three phase inverters to bits DC-DC converter which will be taken care of maximum power point in their project a 100kw PV system was considered. A microcontroller-based grid hitched solar inverter (GTSI) was designed and developed in [11]. Keeping in mind that solar PV power is costly.

MOSFET switching is used for higher DC to AC conversion efficiency. Paper [12], used microcontroller and cascade H bridge topology which increase the efficiency and reliability of the system used by a solar multilevel pulse width modulator inverter. Also, the maximum power point tracking is recognized by us is needed for higher efficiency. The main motive of paper [13] is the composition of an inverter which enable the inversion of a DC power source, supplied by Photovoltaic (PV) Cells, to an AC power source used to drive a three-phase induction motor. In the paper [14], the Sinusoidal pulse width modulation SPWM) method have been proposed for a three-phase inverter. Authors demonstrated the simulation study of inverter designed with 50 Hz transformers Sub topology and reported in [15]. The results reported in the paper are found on the actual design of SPWM inverter and its simulation carried out found on mathematical model. Study of output voltage regulation with respect to variation in Battery voltage, sampling frequency and for different loads is carried out. It was observed that in the battery range 7.5 to 12.2V the regulation is within + 10% of expected output. However, it is necessary to trip the battery voltage beyond 13V, sampling frequency 10 KHz and that output is 230V. The central attention of the paper.

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