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PERFORMANCE IMPROVEMENT OF GRID CONNECTED HYBRID RENEWABLE ENERGY SYSTEM USING MPPT TECHNIQUES

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Abstract: Electricity is needed for daily life and production. Solar wind hybrid systems use a combination of renewable energy sources, such as wind and solar, to generate electricity. Solar panels and small wind turbine generators are used to generate electricity in this setup. There is a developing requirement for the blend of renewable power and power system. Sun based PV and wind power plays a significant part for battery charging, Grid tied applications in the previous 10 years, because of numerous limitations on regular wellsprings of energy input in contamination and ecological harm, there is a need to utilize sustainable power sources. In India, petrol is the essential and normal provider of electric power. Be that as it may, the customary energy emergency has constrained the world to plan for the sun powered and wind system. This paper includes the utilization of photovoltaic and wind power system to plan and extract maximum power of DC networks under factor working voltages. To expand the result power of the photovoltaic system and wind age framework, the most extreme conceivable energy gathered from the photovoltaic system should be found. In this work, the most extreme power point following (MPPT) calculation applied to crossover energy system. To get greatest power annoy and perception and gradual conductance calculation applied to the hybrid system. The exhibition of P & O MPPT applied on MATLAB/SIMULINK stage.

Keywords: Renewable Energy, Solar System, Wind System, Hybrid System, MPPT Techniques

I. INTRODUCTION

Electricity is needed for daily life and production. Solar wind hybrid systems use a combination of renewable energy sources, such as wind and solar, to generate electricity. Solar panels and small wind turbine generators are used to generate electricity in this setup.

To comprehend the operation of a solar wind hybrid system, we must first comprehend the operation of a solar energy system and a wind energy system. A solar power system is a system that harnesses sun energy to generate electricity using solar panels. The figure depicts a block diagram of a solar wind hybrid system in which solar panels and a wind turbine are used to generate power. Wind energy is another renewable energy source that may be used to generate electricity using wind turbines and generators.

The Need for Renewable Energy

Renewable energy is power derived from natural possessions, such as solar, wind, waves, or geothermal energy. These resources are renewable and can be recycled naturally. Therefore, compared to the depletion of traditional fossil fuels [1], these sources of information are considered inexhaustible. The global power crunch provides a new impetus for the development or maturity of clean or renewable energy [2]. In addition to the decline in fossil fuel transportation worldwide, another major reason fossil fuels do not work is the pollution associated with burning fossil fuels. In contrast, it is well known that compared to traditional energy sources, renewable energy sources are cleaner, or energy produced has no adverse effects on pollution.

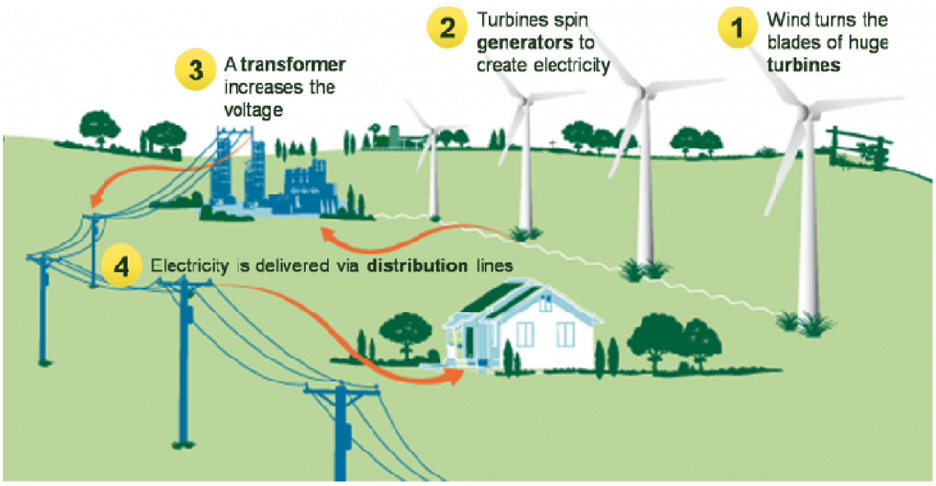

Figure 1 Solar and Wind Power Hybrid Energy Plant

II. DIFFERENT SOURCES OF RENEWABLE ENERGY

Wind Power

Wind turbines can be utilized to outfit the force created by the wind current [3]. The power of turbines used per day is approx 600 kW to 5 MW [4]. Because power output is a function of wind speed, it amplifies hastily as wind speed increases. Recent advances have become wind turbines, which are more resourceful than better aerodynamic construction.

Solar Power

The evolution of solar energy came from the British astronomer John Herschel [5], who used solar collectors for cooking food during his travels to Africa. Solar power can be used in two main ways. First, the extracted heat can be used as energy from the sun and heat the atmosphere. Another option is to convert solar radiation into electrical energy, which is the most needed form of power. This can be accomplished with solar photovoltaic cells [6] or solar-powered power stations.

Small Hydropower

Power plants running with up to 10 MW are considered high-power generators and are regarded as renewable energy sources [7]. It uses hydraulic turbines to convert potential energy for water stored in dams into usable electricity. The purpose of flood power is to use the kinetic energy in the water without the need to build dams or dams.

III. SCOPE OF THE RESEARCH

Global energy demand is constantly growing, and fossil fuel exploration is a priority. These oils are not durable but pollute the environment. The use of RE is affected by the scarcity of fossil fuels and the unfavorable climate because renewable energy is a large part of the energy obtained from the wind and solar. Energy from the sun and wind is a natural source that its use will not damage and is becoming increasingly popular in order to reduce the demand for electricity in the traditional sector of power generation, the optimal use of these natural resources is essential for power generation. There are various methods of using a hybrid solar-wind system with MPPT to generate electricity in practice. For maximum power transmission the constant flow technique is used. This technique should have some significant functions to improve stability and efficiency.

IV. METHODOLOGY

Solar-Wind Hybrid Power System-The electrical system combining wind and solar energy is called a hybrid power system that offers various advantages over one system. Wind speeds are low in many areas in summer, when the sun shines brightest and longest. In winter there is less sunlight and stronger wind. Hybrid systems generate power when necessary. The wind and solar peak operating time occurs at different times of day and year. Many hybrid power systems are stand-alone systems not connected to a distribution system. If wind and solar power are not generated, the hybrid system supplies power via batteries. When batteries run low, the engine generator can provide power and recharge batteries. Modern electronic controllers can automatically operate hybrid systems by adding a motor generator, making the system complex. Due to the engine generator, other components needed for the system should be small in size. The storage capacity should be large enough to supply electricity during non-charge periods. The output solar power system and wind energy system output are combined in parallel, as the other one can compensate if one source is missing. Solar and wind energy systems can work together separately. However by combining these two intermittent sources and by incorporating MPPT algorithms, the system power transfer efficiency and reliability can be improved significantly MPPT is explicitly used to remove the most extreme accessible force from the photovoltaic generator. Most extreme force can be accomplished by following the MPP utilizing particular calculations like P&O and Incremental Conductance (INC). These calculations are the most broadly utilized because of their straightforwardness of execution contrasted with different calculations. It additionally shows the hypothesis of activity of the P&O and INC calculations. During reproduction (utilizing MATLAB/Simulink), calculations are assessed under various working conditions and every calculation enjoys upper hands over the other. P&O is the quickest to arrive at MPP and charge the battery, however like the INC calculation, it cannot retain the MPP.

In the meantime, INC can access the MPP with lower disturbances, lower switch speed, higher efficiency and higher component life. MATLAB/SIMULINK simulates the proposed configuration. Both simulation and experimental results correspond closely to the theoretical expectations.

Hybrid Solar - Wind System Modeling

PV array, wind turbine, battery bank and inverter, controller and cables form the hybrid solar-wind system. The photovoltaic and wind turbines work together to meet load requirements. When the energy sources (solar wind) are plentiful, the power generated from the solar power continues to charge the battery during the day until it is charged fully. Unlike in low energy sources, the battery releases energy that helps the PV array and the wind turbine meet load requirements until the storage is depleted. The modeling of the hybrid solar-wind system depends mainly on the performance of each component. To predict system performance, the two energy sources should be modeled separately and combined to meet demand reliability. The resulting combination supplies power effectively if the prediction of power output from these individual sources is accurate enough. A hybrid system could be designed to run in isolated mode or network connected mode via electronic power interface.

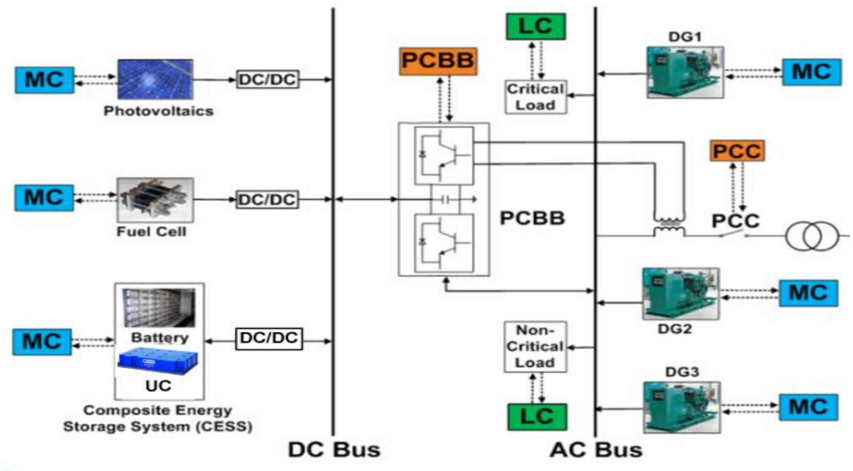

Figure 2 Architecture Diagram

4.2 Modules

- Solar Power System
- Wind Power System

- MPPT Algorithm
- Boost Converter
- Bidirectional Converter
- Battery
- Dual Active Bridge
- PWM Switching

MPPT Algorithm

There are various MPPT techniques. MPPT technologies will be converse.

Hill-Climbing Techniques

Many types of MPPT algorithm are available. Some of the popular MPPT schemes are hill climbing method, incremental conductance method, constant voltage control method, modified hill climbing method, system oscillation method and ripple correction method etc.In hill claiming method the duty cycle is continuously perturbed at regular intervals and the resulting voltage, current and then power are obtained. Once the power is obtained, the slope of the PV curve is checked. Based on the positive slope and negative slop of the PV curve the following correction is carried out.

In voltage source region, $\frac{\partial P_{PV}}{\partial V_{pv}} > 0 \rightarrow D = D + \Delta D$(Increment D)

In the current source region, $\frac{\partial P_{pv}}{\partial V_{pv}} < 0 \rightarrow D = D + \Delta D$ (Decrement D)

At MPP, $\frac{\partial P_{pv}}{\partial v_{pv}}$ =0→ $D = Dor\Delta D = 0$ (Retain D)

Where, D is duty cycle and D is change in duty cycle. As per equation 3.1 to 3.3, P_{new}>P_{old}, the duty cycle is increased. This means that the slop is positive and the operating point is in the constant current region. Incase P_{new}<P_{old}, the duty cycle is reduced. This means that the slope is negative and the operating point is in the constant voltage region (Ting- Trishan & Patrick 2007). The algorithmic steps of hill climbing algorithm are given below.

Algorithmic steps:

Step 1: Measure the value of voltage and current of solar PV.
Step 2: Set the modulation index m.
Step 3: Calculate the initial power Pm.
Step 4: Increase the value of m.
Step 5: Sense the voltage and current of solar PV.
Step 6: Calculate the modified power Pf.
Step 7: If the change in power is positive, increase m, if it is negative decrease the value of m. If no change the value m is maintained.

Step 8: Repeat step 5.

Perturb and Observe

The P&O algorithm is also called "climbing," but both names refer to the same algorithm depending on its application. The correction includes disruption of the power cycle of the power converter and P&O and disruption of the working power of the DC link between the photovoltaic array and the power converter. On the upside, interrupting the power converter's circuit breaker means changing the DC link between the PV array and the power converter so that one technology refers to the same technology. In this method, the final turbulence and the increase in the final turbulence signal areused. To determine the expected subsequent turbulence. Fig.3 shows that an increase in power increases the power, while on the right side of the MPP, a decrease in power increases the power.

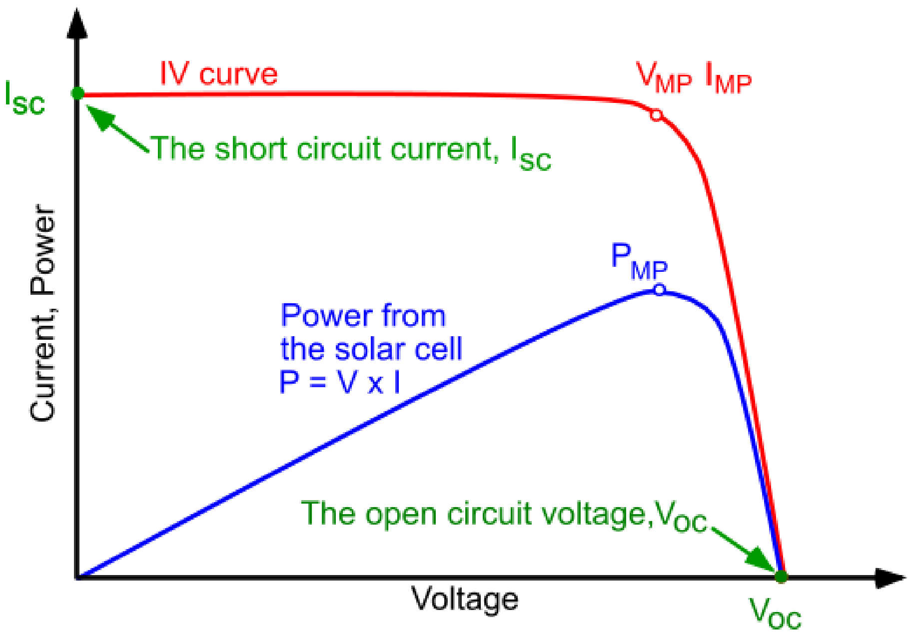

Figure 3 PV Panel Characteristic Curves [11]

4 Simulation Results and discussion

Table 1: Simulation Parameter

SIMULATION PARAMETERS	VALUES
KP	40
electrical generator (V.A.):	8.5e3/0.9
Engine time delay (Td (s))	-0.024
Nominal power(W)	2e+006

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Voltage(V)	400
Frequency(Hz)	50
Field current(I)	100
Open circuit voltage, Voc	0.62
Short circuit current,	7.57
PV output(Kw)	230 kW
Wind power	4.5
Base wind speed (m/s):	12
Load power P (W)	100

V. Simulation results of Perturb and Observe Method

The generation of sole and wind is well-known as an alternative source of green energy generation, which can mitigate the energy demand issues. This paper introduces an independent hybrid power generation system comprising wind power sources and an AC load from a solar and permanent magnet synchronous generator (PMSG). In order to maximize simultaneous energy collection from overall power generation under various climatic conditions, a supervisory control unit is created to carry out MPPT. Two contingencies are considered and classified according to the energy generation and the load requirement of each source of energy. The Perturb & Observe (P&O) PV system uses the maximum power point tracking (MPPT) controller as the control logic and the Hill Climb Search (HCS) algorithm is used as the MPPT control logic to maximize wind power generation.

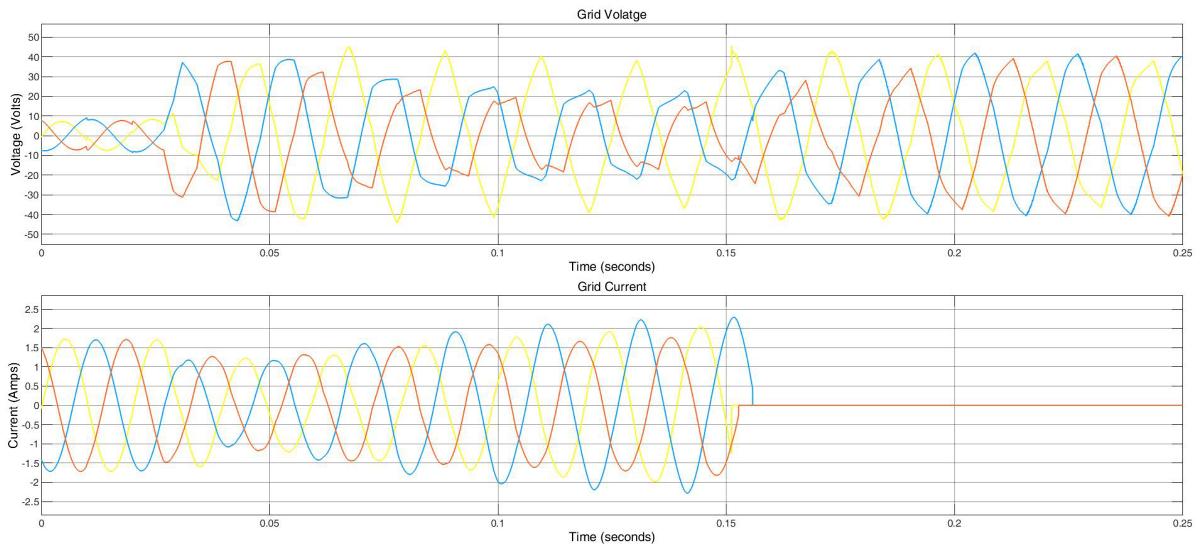

Figure 4 Grid Voltages and Current

Fig 4 showing the grid voltage and current. At 0.15 seconds Circuit breaker present in grid is open and no current flow through the grid. The load present in the grid will also disconnect but critical load will get the power from the inverter.

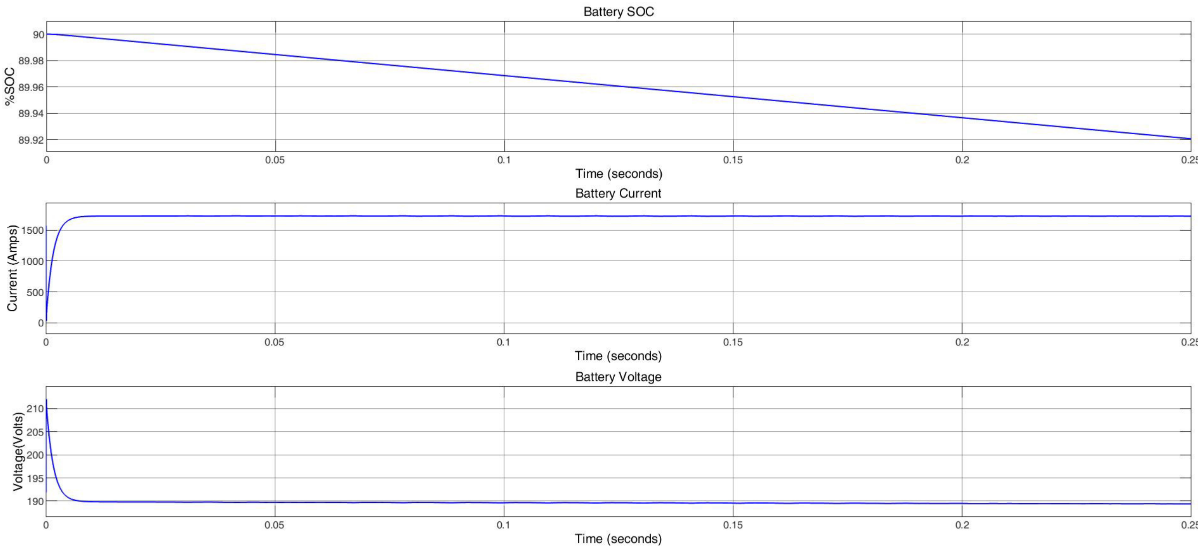

Figure 5 Battery Output

The fig 5 showing the battery output (voltage, current and state of charge State of charge (SOC). The state of charge is defined as the ratio of the available capacity Q(t) and the maximum possible charge that can be stored in a battery.

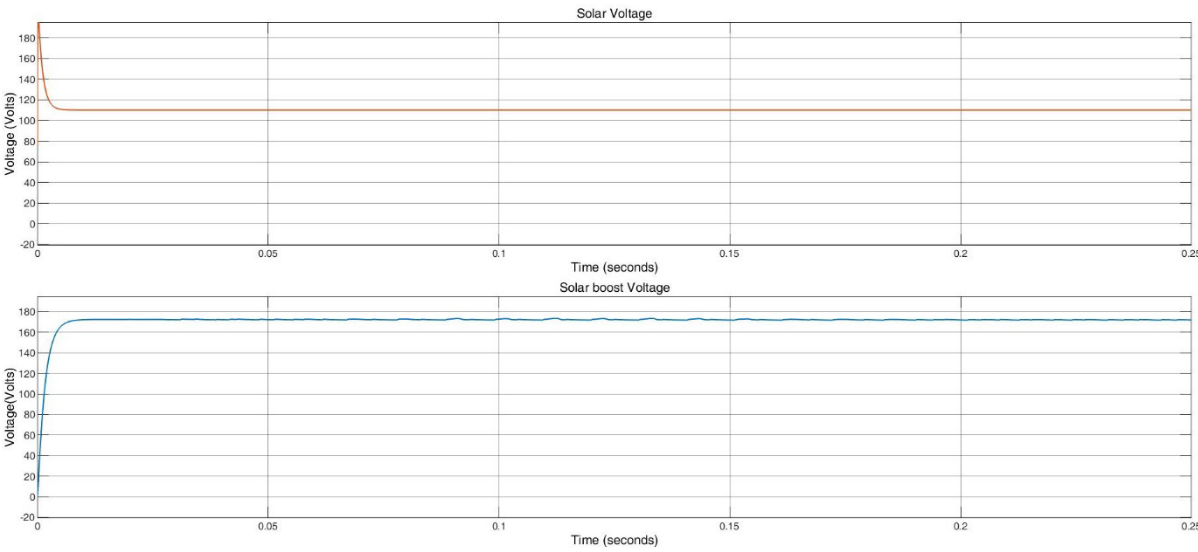

Figure 6 Solar Voltages: Before and after boost converter

The figure 6 shows the voltage received from the solar panel is 110 volts and when passed through the boost converter we get 172 volts.

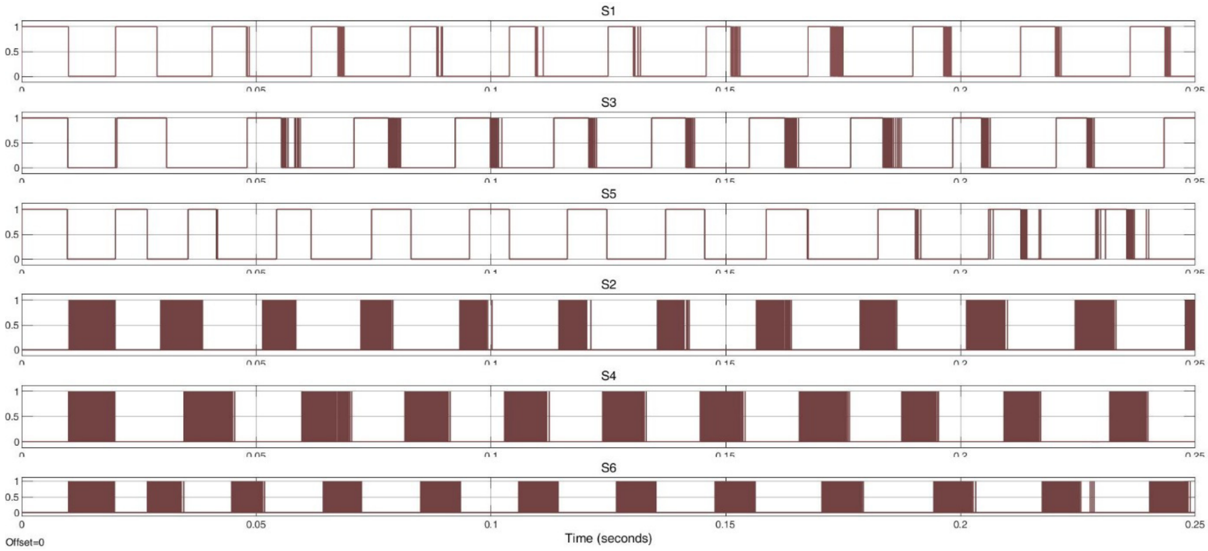

Figure 6 Pulses to operate the Inverter

Using the MPPT pulses are generate for the Rectifier switches as shown in figure 7. S1 denotes the pulse for the IGBT switch 1, likewise S2 for IGBT switch 2 and so on.

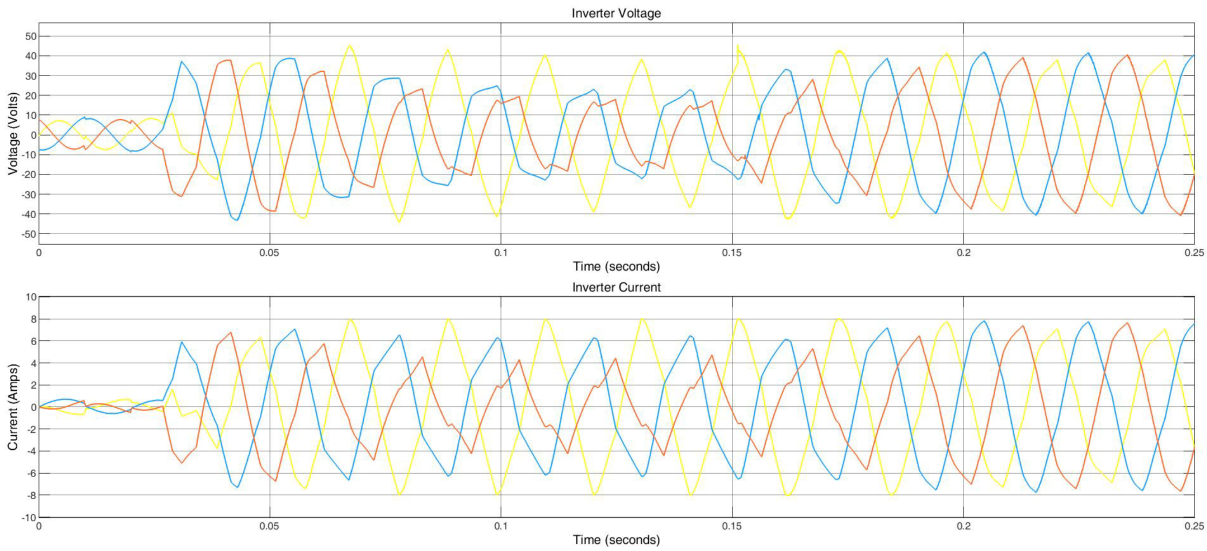

Figure 8 Voltage and Current at inverter

Output voltage and current waveforms produced from the inverter is shown in figure 8.

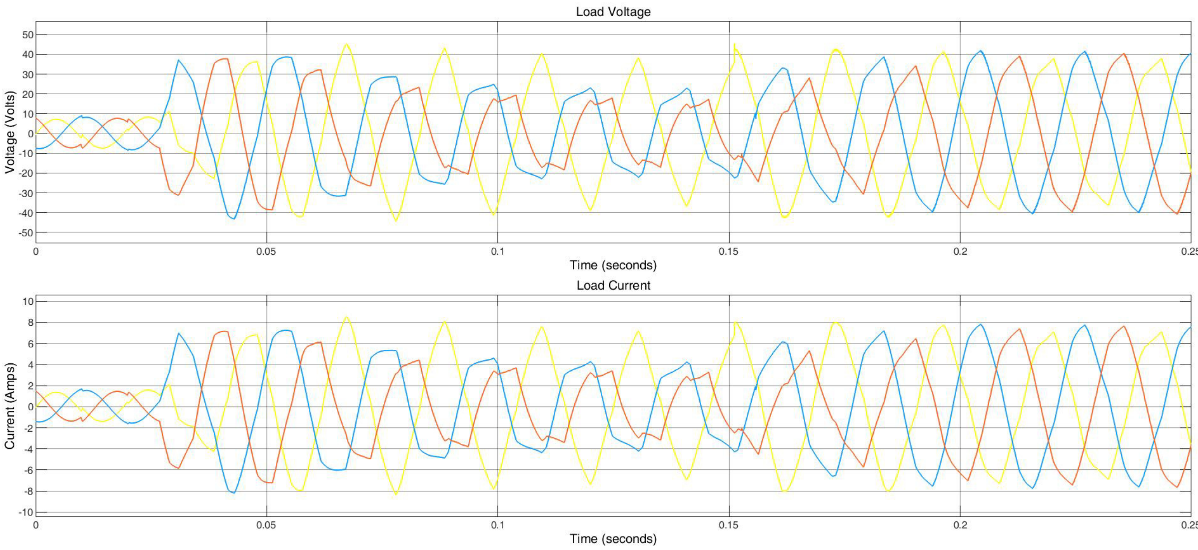

Figure 9 Critical Load Voltage and Current

From figure 9, we can clearly see that even after grid supply is disconnected at 0.15 seconds, critical load continues to get power from the inverter.

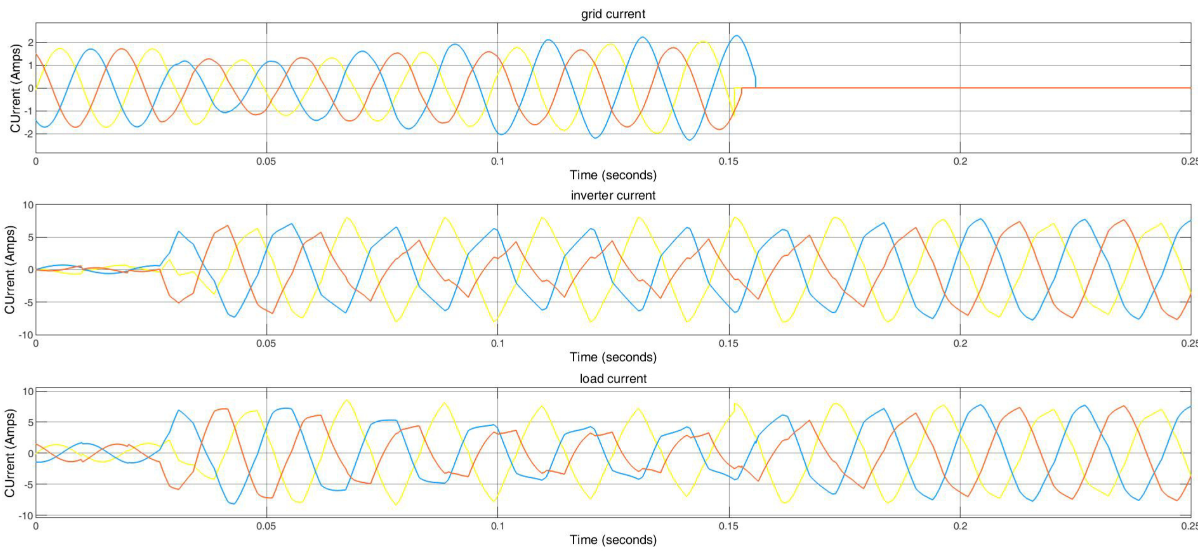

Figure 10 Grid, Inverter and Critical Load Currents

Here, in this figure 10, grid current, inverter current and critical load current is compared.

In this clearly shown that at 0.15 seconds grid is not supplying any current but critical load will get current from inverter. After 0.15 seconds currents of inverter and critical load is same.

VI. CONCLUSIONS AND FUTURE SCOPE

In the simulation results got for the most extreme power, irritate, perception, based MPPT calculation. The general presentation examination of a half and half-based lattice joining framework to give the capacity to basic burdens. Single source sustainable power age can accordingly satisfy load needs, the PV-Wind half and half model is proposed to counterbalance the impacts of natural variables and environment varieties of the assets influencing the proceeding with activity of force age. Perturb and Observe (P&O) MPPT innovation is utilized for the proficient following of sunlight based and wind energy and a lift converter are utilized to eliminate inverter variances in the change of capacity to AC. The loads will get the supply from the PV -Wind, battery, and grid in normal condition. In fault condition the Critical load will get the power from the PV-wind hybrid system. If no irradiance and wind is present, then the battery will be able to provide supply to the critical load.

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