Supply of Uninterrupted Electrical Power Using Hybrid Energy Sources

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Abstract
This project suggests a number of converters that are incorporated into the utility grid from renewable sources, along with suggested control mechanisms. Through the BOOST converter, the solar panel supplies voltage to the inverter. With the help of a battery system and a bidirectional battery converter, the suggested system achieves energy management. When there isn't any sunshine, the AC mains are used as a backup source to keep the power supply going. The AC supply also powers the inverter, and any extra energy is stored in the battery. By using this strategy, we can guarantee that power will always be available, even in the event of a power outage or lack of sunlight. The battery's energy storage will supply the inverter with the necessary current.

Keywords:*Converters, Renewable sources, Energy management, Grid integration, Harmonics reduction, Sinusoidal waveforms, Control strategies*

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I. INTRODUCTION

An advanced electrical gadget known as a hybrid inverter blends the features of an off-grid, battery-operated inverter with the typical grid-tied inverter. This cutting-edge technology offers a flexible solution for renewable energy applications by managing and optimizing the flow of electricity in both independent and grid-connected systems. A hybrid inverter is essential to the integration of solar panels with energy storage devices, like batteries, in solar power systems. The hybrid inverter effectively transforms solar energy into electricity for immediate use during times of abundant sunlight, giving extra power back into the grid if connected. It charges the linked batteries concurrently, storing extra energy for use in the event of power interruptions or when solar generation is insufficient. The ability of hybrid inverters to switch between grid-tied and off-grid modes smoothly is one of their main benefits. The hybrid inverter immediately shifts to using the energy stored in the batteries in the case of a power loss or when solar energy is inadequate, guaranteeing a steady and dependable power source. Because of its capacity to increase energy independence and resilience, hybrid inverters are a great option for places with unstable grid infrastructure or for people looking to maximize their own use of renewable energy. Moreover, sophisticated hybrid inverters frequently have monitoring tools and intelligent features included. These consist of energy management programs, remote monitoring, and programmable settings that let users prioritize certain loads, optimize energy use, and keep an eye on system performance in real time.

1.1 OBJECTIVE OF THE PROJECT

• To get the most power possible from the AC mains and PV system.

• To use a Boost converter to provide a high output DC voltage.

• To use a battery system and a bidirectional battery converter to manage energy in the proposed system.

• Alternatively, the inverter can be powered by the AC mains, with any extra energy being stored in the battery.

II. LITERATURE SURVEY

A) An Approach Towards Extreme Fast Charging Station Power Delivery for Electric Vehicles with Partial Power Processing IEEE TRANSACTIONS ON INDUSTRIAL ELECTRONICS, VOL. 67, NO. 10, OCTOBER 2020

A method for implementing the power supply scheme for an XFC (extreme fast charging) station, which is intended to charge several EVs at once. Galvanic isolation is achieved by means of dual-active-bridge based soft-switched solid-state transformers, while a cascaded H-bridge converter is employed for direct medium voltage grid interface. By charging the individual EVs using partial power rated dc-dc converters, the suggested method does away with redundant power conversion. While only processing a portion of the overall battery charging power, partial power processing allows for individual charging control over each electric vehicle. Analysis is done on workable implementation plans for the partial power charger unit. A charger based on a phase-shifted full-bridge converter is suggested. Clear explanations of the design and control factors are provided for permitting numerous charging points.

B) Grid-Integration of Battery-Enabled DC Fast Charging Station for Electric Vehicles, October 2019, IEEE Transactions on Energy Conversion PP(99):1-1 , DOI:10.1109/TEC.2019.2945293 :

It creates and assesses a control structure and system design to lessen the negative effects of an EV's DC fast-charging station on the host weak AC grid. The charging station has a battery energy storage system, and its control system decouples the station's dynamics from those of the grid in addition to (i) limiting imported power based on grid requirements. The charging station can function in both islanded and grid-connected modes. In order to construct the Local Controllers (LCs), eigenvalue studies were conducted and the charging station's dynamic models in both modes are given.

C) Smart charging strategy for electric vehicle charging stations IEEE Transactions on Transportation Electrification , ID- 26120 :

Although there is great potential for transportation electrification to address the issue of environmental pollution worldwide, plug-in electric vehicles (PEVs) have not yet gained much traction in the market. This low adoption rate is mostly due to consumer worries about the scarcity of charging stations and the excessively long charging times. A prolonged PEV peak demand period may coincide with the residential peak load period, which could complicate energy management from the standpoint of the electrical grid. These problems can be addressed with a well-designed charging plan, which is what inspired us to carry out this investigation. Finding the best charging station for a plug-in vehicle (PEV) that needs facilities for charging is modeled as a Mult objective optimization problem, with the objective being to choose a station that guarantees the lowest possible charging time, trip time, and charge cost. We expand the model to include an ant colony optimization as a metaheuristic solution.

D) B.S.S.A, S.M.A, V.P.G, S.I, K.S.K. B and V. Rao Ch, "Arduino based Smart Street Light System," 2021 3rd International Conference on Advances in Computing, Communication Control and Networking (ICAC3N), 2021, pp. 657-660, doi:10.1109/ICAC3N53548.2021.9725439:

The primary goal of the street lighting system is to illuminate the area at night in order to promote public safety and accident prevention. Both manpower and a significant amount of electricity were needed to maintain these street lighting systems. India is one of the world's major developing nations that is currently experiencing power shortages as a result of a rapid population growth. In the modern era, reducing power shortages is a very difficult problem to solve because natural resources like coal and fossil fuels are depleting quickly. Therefore, it is crucial to implement an effective street light management system that can increase efficacy in order to reduce power consumption and nighttime traffic accidents. An Arduino-based Smart Street light system that automatically turns on and off street lights during the night or in cloudy conditions has been proposed in this work. Additionally, a passive infrared sensor has been used to detect vehicle motion at night. During the day, the street light is off regardless of vehicle traffic; however, at night, the street light turns on whenever a vehicle movement is detected by a PIR sensor. The proposed system works best in rural villages, smart villages, and highways. This study proposes an Arduino-based Smart Street light system that can turn on and off street lights on its own at night or during overcast weather. In addition, motion of a vehicle at night has been detected using a passive infrared sensor. Regardless of vehicle activity, the street light is off during the day; but, at night, it turns on when a PIR sensor detects movement in a car. The suggested approach functions well on highways, in smart villages, and in rural areas.

E) A UNIFIED CONTROL AND POWER MANAGEMENT SCHEME FOR PV-BATTERY-BASED HYBRID MICROGRIDS FOR BOTH GRID-CONNECTED AND ISLANDED MODES , MAY 2017 , IEEE TRANSACTIONS ON SMART GRID, PP(99):1-1 DOI:10.1109/TSG.2017.2700332.

This offers a fully integrated power and control management system (CAPMS) for two PV-powered microgrids that can function as islands or as part of a grid. There are dc and ac busses in the system. Even in the face of disruptions from shifting operating modes, variations in temperature and irradiance, and fluctuations in load, the suggested CAPMS is effective in maintaining stable ac and dc bus frequency and voltages, adaptable control over the voltage and power of each unit, and automatic power flow managing in the systems under various operating conditions.

F) Vector-Based Synchronization Method for Grid Integration of Solar PV-Battery System September 2019, IEEE Transactions on Industrial Informatics 15(9) DOI:10.1109/TII.2019.2921034.

explains a method for synchronizing a solar photovoltaic (PV) battery system with the grid that is vector-based in nature. The point of common coupling voltages and the three-phase grid voltages are converted into two vectors in the α-β plane using this technique. Instantaneous voltage changes are taken into consideration in this technique, which is simple because it does not rely on a phase-locked loop or feedback. While the islanded system runs in voltage control, the grid-connected solar PV-battery system runs in current control mode. In both grid-connected and islanded modes, experimental results are obtained on a grid-solar PV-battery system. A thorough analysis is also conducted of the two transitions between these operational modes.

III. PROBLEM STATEMENT

When there is a power outage, inverters are frequently utilized to supply homes, workplaces, hospitals, and other establishments. However, the limited battery capacity of these devices means that we must use inverters that run on renewable energy to solve this issue. Similar to solar energy, inverters powered by renewable energy are inexpensive and simple to maintain. This technique allows batteries to be charged by AC mains and solar power, and it also uses the battery's stored energy in the event that neither source is available. Alternatively, the inverter is powered by the AC mains, and any extra energy is stored in the battery. This way allows us to always have a steady supply of electricity.

- *PROPOSED STATEMENT:*

The suggested method is to use both solar and AC main power for the supply, boosting the voltage with a boost converter that receives the voltage from the solar panel. An inverter receives the increased voltage in order to convert the DC voltage to AC voltage. We also employ an AC supply as a backup source so that the inverter will always have the voltage it needs in the event of a blackout. We use a rectifier to change the AC voltage from the AC source into DC so that any excess energy can be stored in the battery. The battery's energy will be used to provide energy during a blackout and in the absence of sunlight.

Hardware Parameters and Components Description

Solar Panel	12 Volt, 10 Watt
Rechargeable Battery	12 Volt, 7.2 Ah
Relay	12 Volt DC
Diode	Simple P-N junction diode
L.E.D.	3-3.2 Volt forward voltage drop
Transistor	Silicon based BJT
Transformer	12-0-12v to 220v
Bulb	230 Volt , 5 Watt
Resistors, capacitors, jumper wires,2 pinplug etc	-
Mosfet	-

A. COMPONENTS DESCRIPTION:

a) Solar panel:

One tool for absorbing sunlight and converting it into heat or power is a solar panel. It is made up of a number of solar cells, sometimes referred to as photovoltaic cells, that are organized on the panel's surface in the form of a grid. When sunlight is absorbed by these solar cells, the photovoltaic effect is used to generate electricity. Crystalline silicon solar cells, which are renowned for their dependability and efficiency, make up solar panels. A module made up of the assembled and connected cells is fixed atop a supporting structure. Through solar absorption, the module generates direct current (DC) electricity.

An inverter is used to change DC electricity into alternating current (AC) electricity that can be used in residences and commercial buildings. Electrical equipment and gadgets can be powered by the AC electricity that the inverter transforms from DC electricity. In solar photovoltaic systems, solar panels are frequently utilized to produce electricity for usage in homes, businesses, and industries. Additionally, they are employed in solar thermal systems to heat air or water for a variety of uses. Since solar panels don't release greenhouse gases during the production of clean, renewable electricity, they are well-known for their sustainability and environmental advantages. They are an essential part of solar power systems and are vital to the shift to renewable and sustainable energy sources in the future.

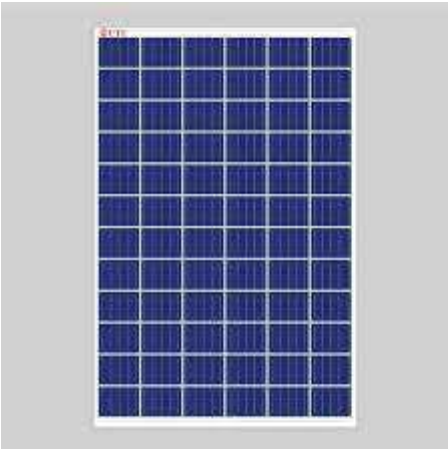

Fig. a. Solar pannel

b) Rechargeable battery:

An energy-storage gadget that can be recharged repeatedly after being depleted is called a rechargeable battery. It serves as a substitute for throwaway batteries, which are meant to be used just once before being thrown away. Because rechargeable batteries are meant to be reused, waste is decreased and a more economical and environmentally friendly alternative is offered. Chemical energy is stored by rechargeable batteries and can be transformed back into electrical energy when needed. They usually comprise of one or more cells, with an electrolyte that permits ions to move between the electrodes and two electrodes—a positive electrode, also known as the cathode, and a negative electrode, often known as the anode.Ions travel between the electrodes of a rechargeable battery when it is discharged due to chemical reactions within the cell, producing an electrical current. When the battery is almost empty, it can be replenished by passing an external electrical current through it, which stops the chemical reactions and causes the ions to return to their starting places. There are several different kinds of rechargeable batteries, such as lithium-ion (Li-ion), nickel-metal hydride (NiMH), and nickel-cadmium (NiCd). Regarding energy density, voltage, capacity, and longevity, each kind varies. To guarantee correct charging and avoid overcharging, certain rechargeable batteries need to be used with particular chargers. In general, rechargeable batteries offer an environmentally friendly and cost-effective way to power a variety of gadgets while cutting down on waste and negative effects on the environment.

Fig. b. Rechargeable battery

c) Diode:

A diode is a semiconductor device that primarily functions as a current one-way switch. It makes it difficult for current to flow in the other direction while permitting it to flow in one direction with ease.

Because they convert alternating current (ac) into pulsing direct current (dc), diodes are often referred to as rectifiers. Diodes are rated based on their voltage, type, and current carrying capacity.

An anode (positive lead) and a cathode (negative lead) determine the polarity of a diode. The majority of diodes only permit current to flow when the anode receives a positive voltage. This graphic shows several arrangements of diodes.

Fig. c. Diode

d) Silicon-based bipolar junction transistor:

One kind of transistor that uses silicon as the semiconductor material is a silicon-based bipolar junction transistor (BJT). Three layers make up the BJT: the emitter, base, and collector. The behavior of the transistor is determined by the doping of these layers with impurities to form either p-type or n-type regions.

Fig. d. Transistor

e) Transformer:

A transformer is a passive part that connects electrical current in one or more circuits to another circuit. Any transformer coil experiencing a change in current causes the transformer's core to experience a change in magnetic flux, which in turn causes variations in the electromotive force (EMF) across any other coils wound around the same core. Without a metallic (conductive) connection between the two circuits, electrical energy can be transported between distinct coils. Discovered in 1831, Faraday's law of induction explains the induced voltage effect in any coil caused by a fluctuating magnetic flux surrounding the coil.

Fig.e. Transformer

F) Microcontroller:

The Microcontroller PIC16F87XA is an 8-bit CMOS FLASH-based CMOS microcontroller that packs Microchip's potent PIC® architecture into a 40- or 44-pin package. It is upwardly compatible with the PIC16C5X, PIC12CXXX, and PIC16C7X devices. It is powerful (200 nanosecond instruction execution) and simple to program (only 35 single word instructions). Self-programming, 256 bytes of EEPROM data memory, an ICD, two comparators, eight channels of 10-bit analog-to-digital (A/D) conversion, two capture/compare/PWM functions, a synchronous serial port that can be set up as a 2-wire or 3-wire Inter-Integrated Circuit (I/C) bus, and a Universal Asynchronous Receiver Transmitter (USART) are all features of the PIC16F877A. It is perfect for more complex level A/D applications in consumer, industrial, automotive, and appliance applications because of all these features.

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Fig. f. Microcontroller

BLOCK DIAGRAM

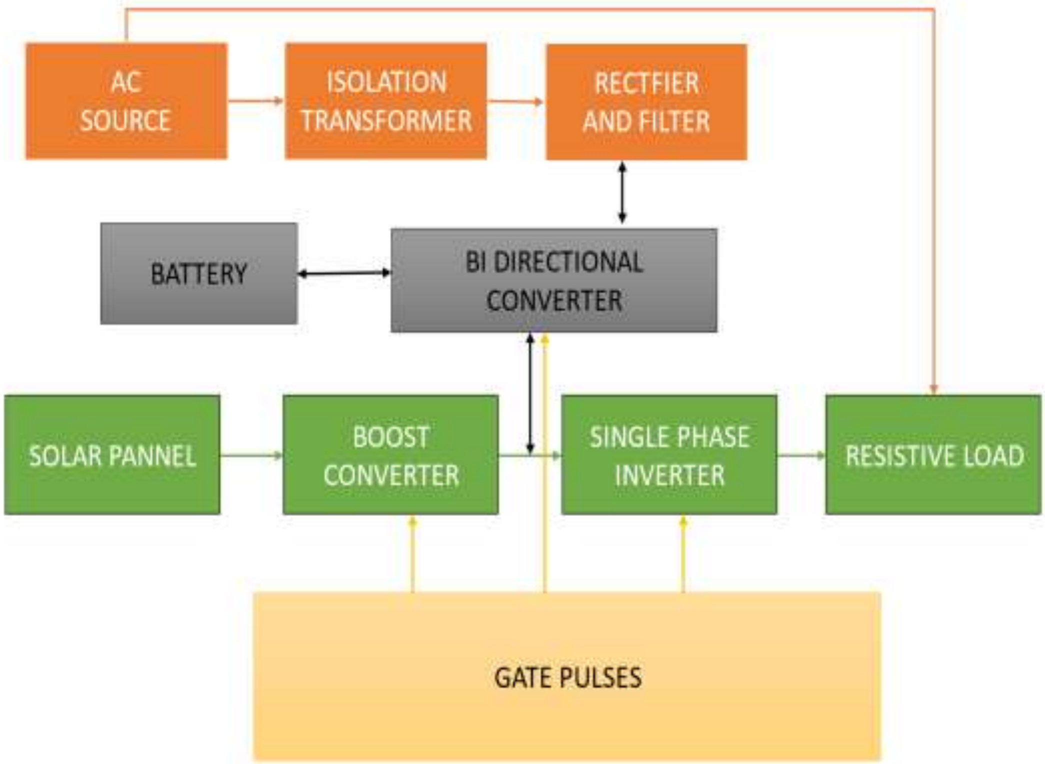


Fig. g. BLOCK DIAGRAM

A. BLOCK DIAGRAM – DESCRIPTION

- **S**olar panel and AC source provide the necessary voltage for powering the inverter.
- The voltage from the solar panel is boosted using a boost converter.
- AC voltage from the AC source is converter into DC using a Rectifier in for battery charging.
- Battery charging is done using the Bi directional converter.
- Both the voltage from the PV panel and AC source is given to a resistive load after converting into AC by an inverter.

CIRCUIT DIAGRAM

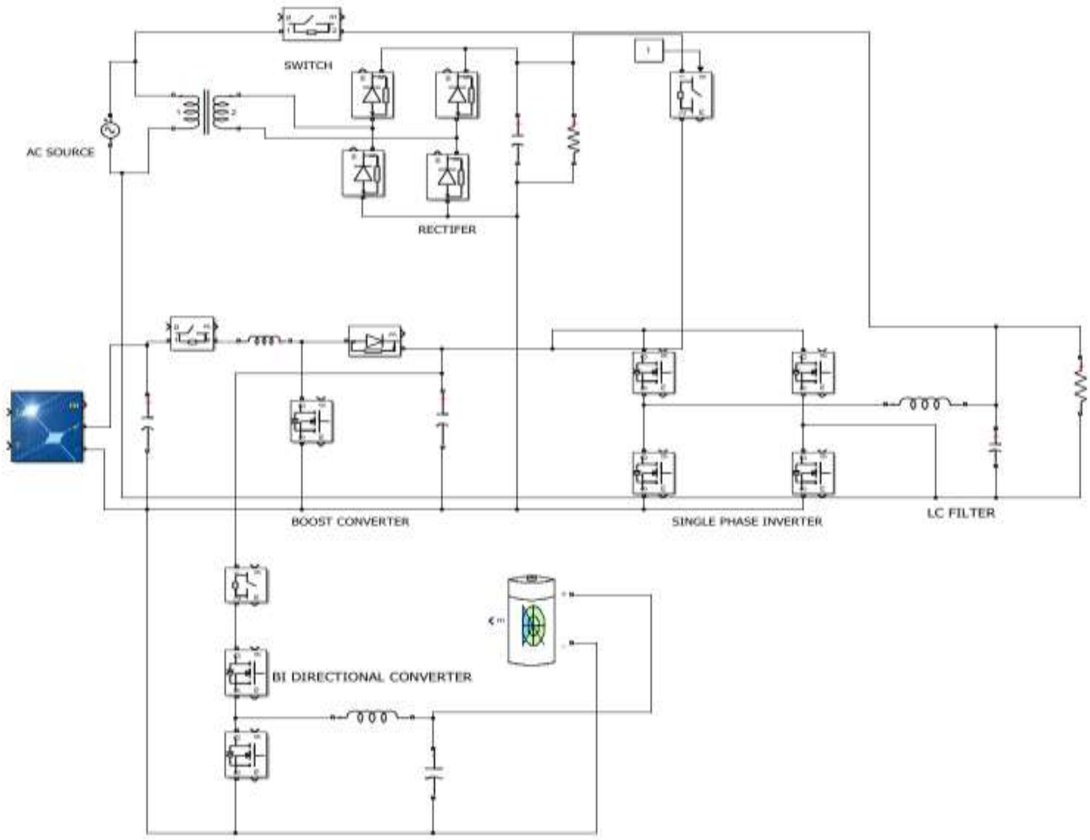


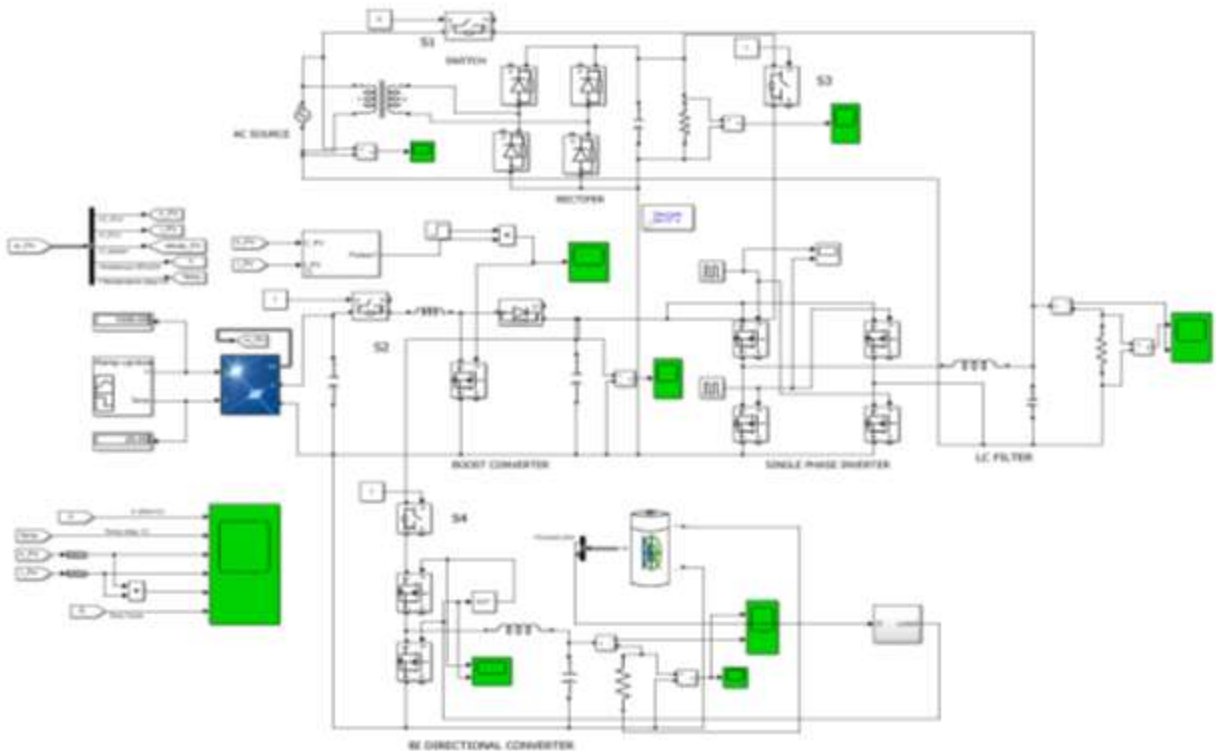
Fig. h. CIRCUIT DIAGRAM

CIRCUIT DISCUSSION

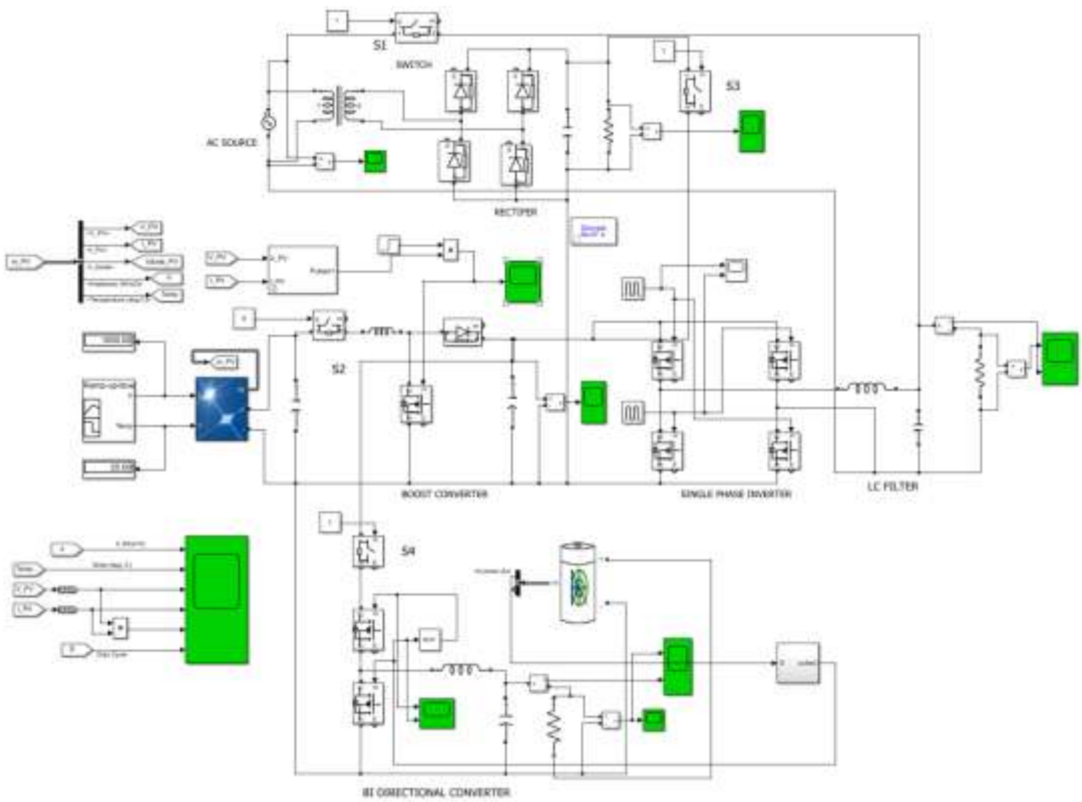
- A circuit diagram for a hybrid energy system for the supply of uninterrupted electrical power would typically involve multiple components.
- The components would include a solar panel, a single phase Inverter, a battery bank for energy storage, a Bi directional converter, boost converter, Rectifier, isolation transformer and an AC source.
- The circuit diagram would detail the specific components and connections required to assemble the hybrid energy system, but would depend on the specific location, energy requirements, and system specifications.

SIMULATION DIAGRAM :

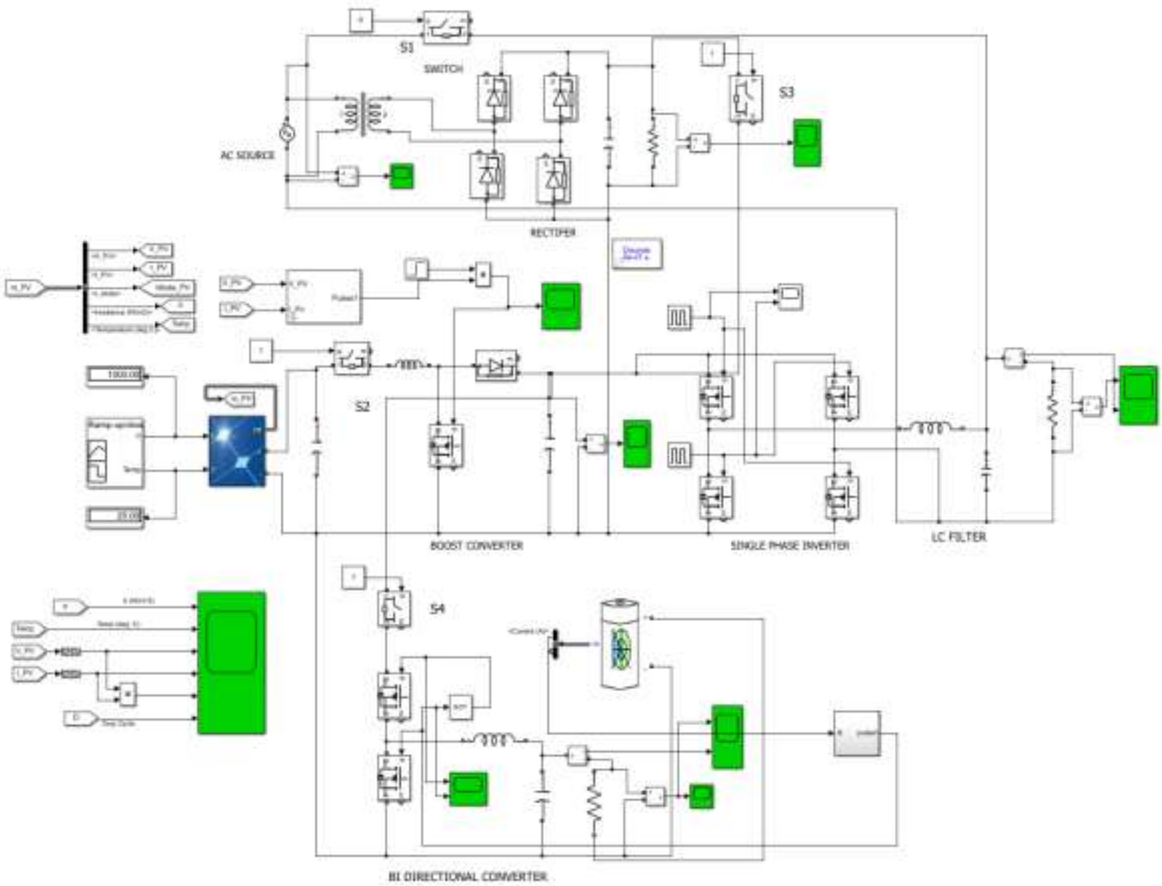
1. SOLAR OPERATING MODE



2. AC OPERATING MODE

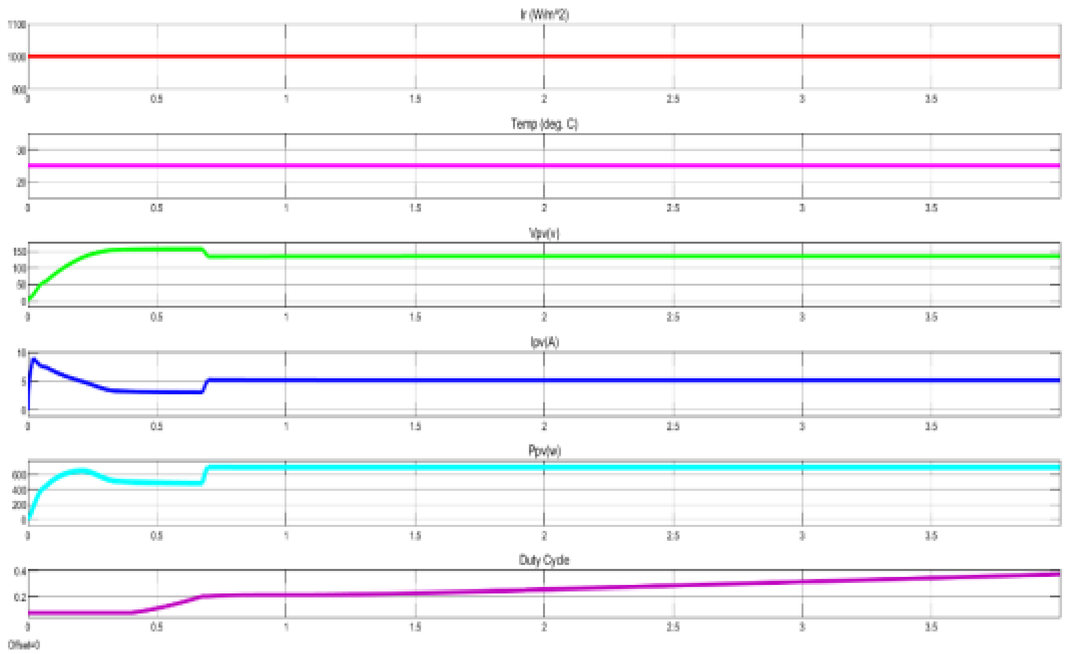


3. BATTERY SIDE

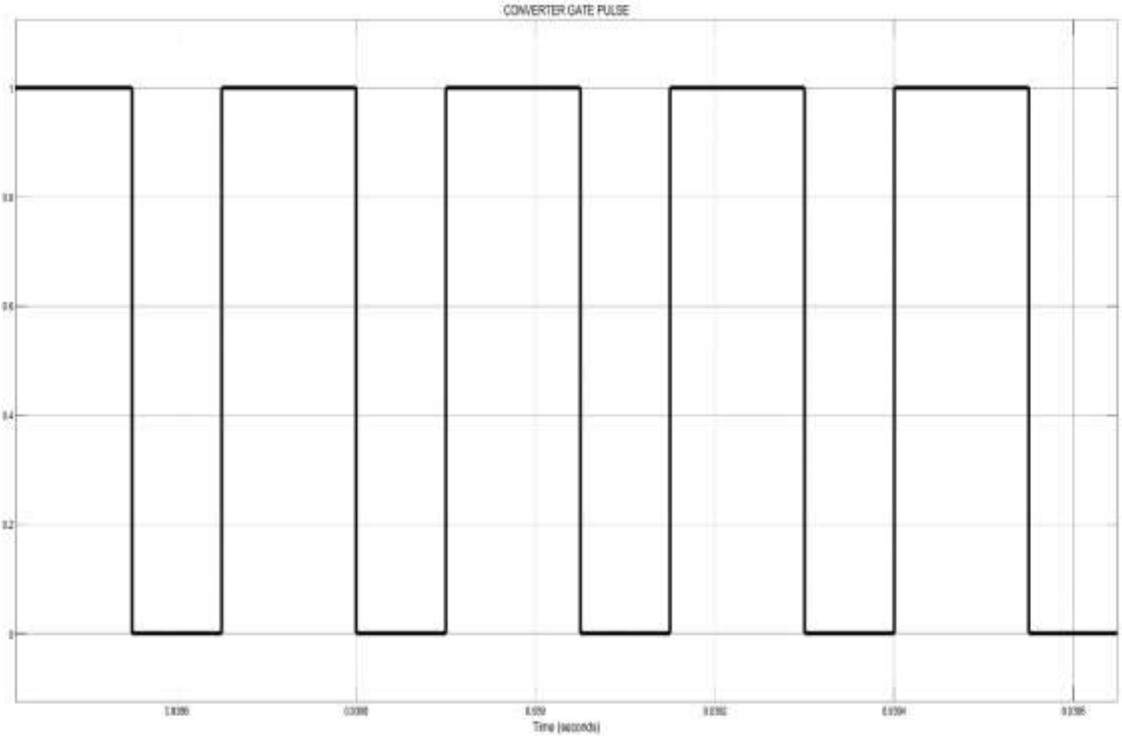


SIMULATION RESULTS

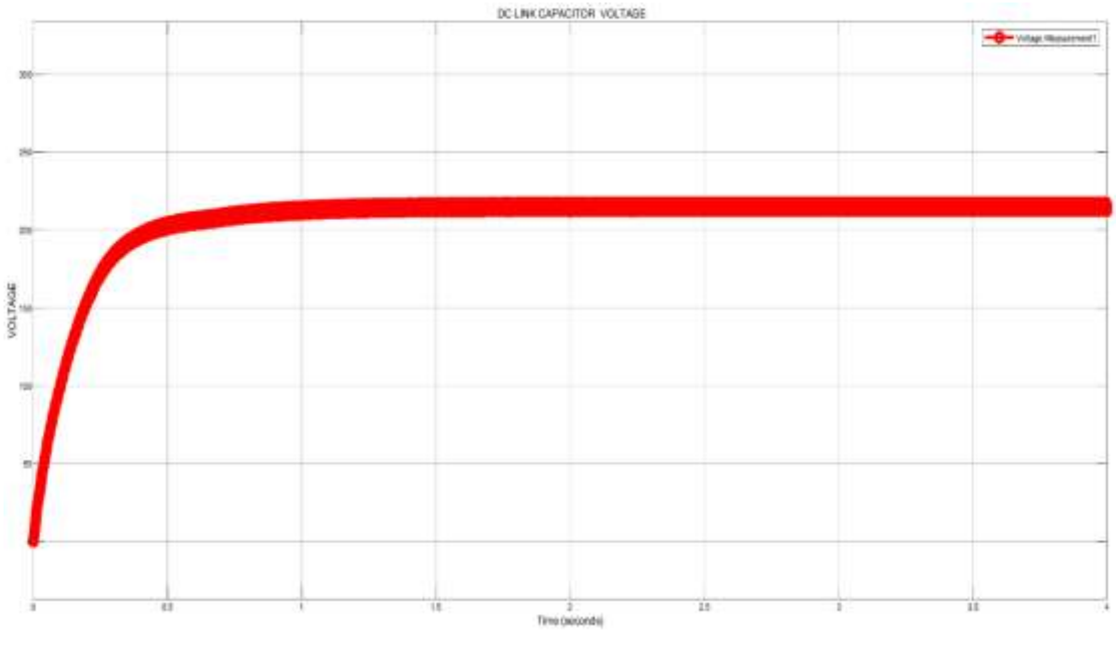
[1] PV SIDE



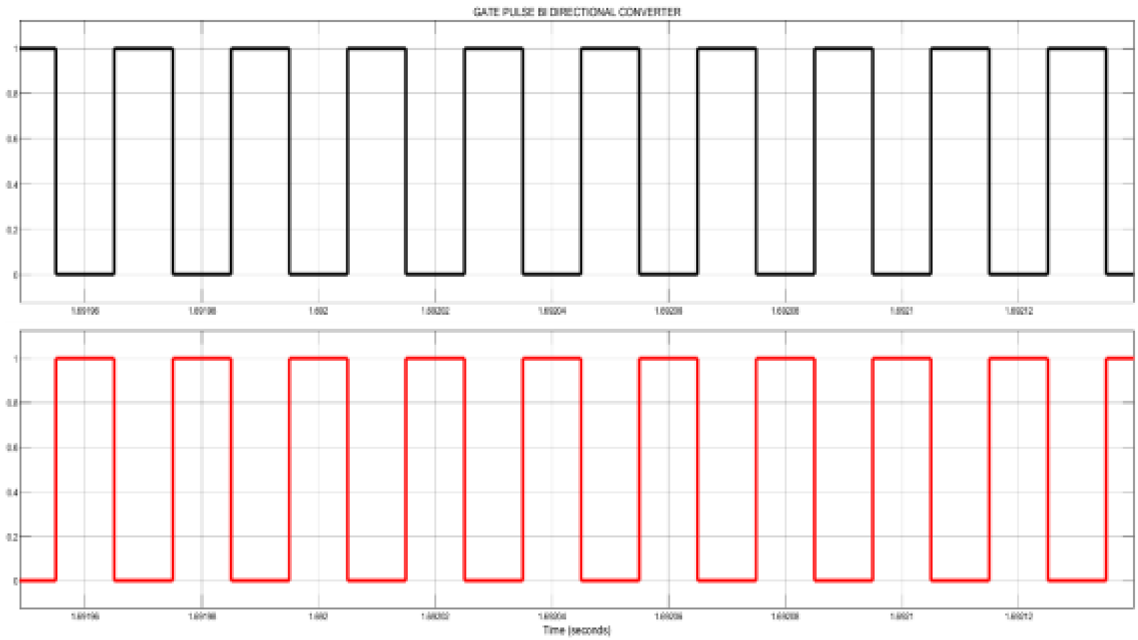
[2] CONVERTER GATE PULSES



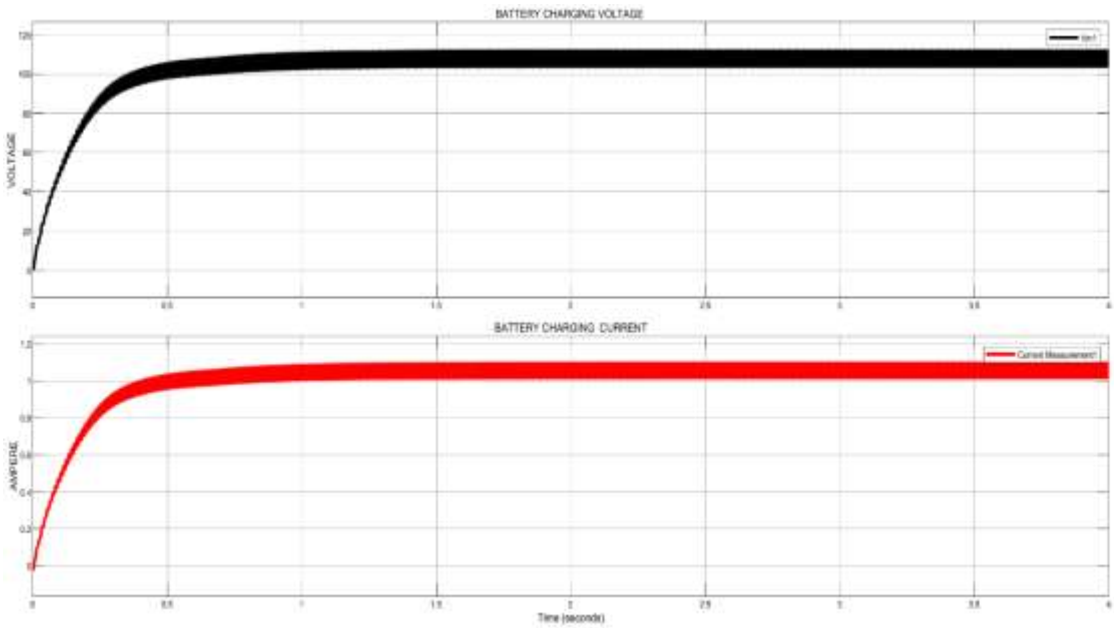
[3] DC LINK CAPACITOR VOLTAGE



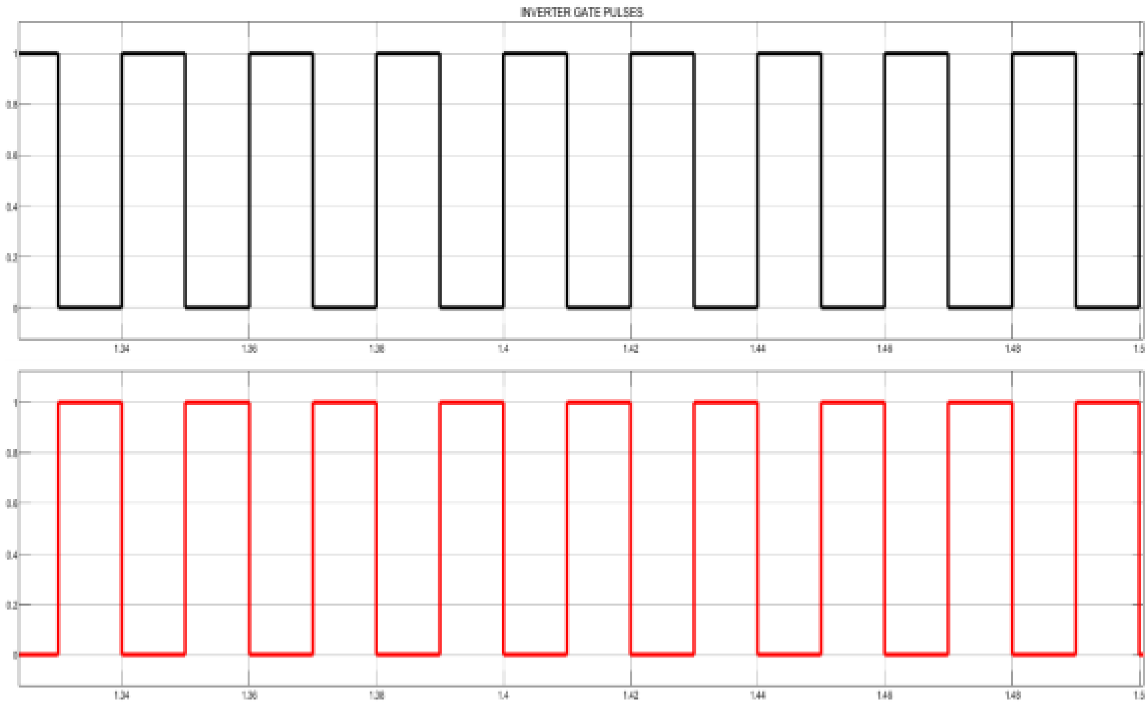
[4] GATE PULSE BI DIRECTIONAL CONVERTER



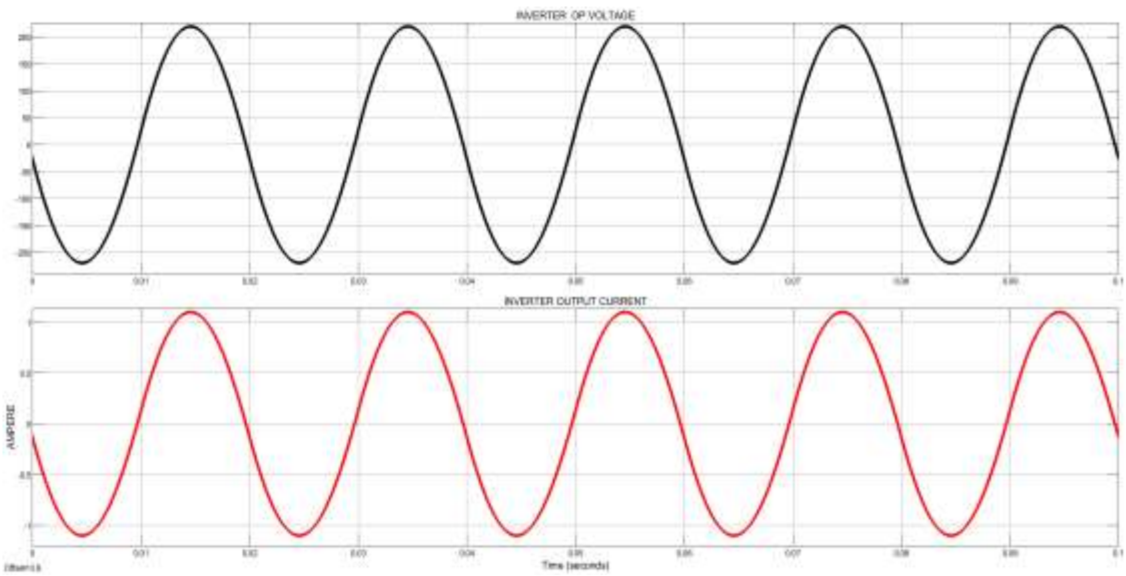
[5] PV SIDE BATTERY CHARGING VOLTAGE AND CURRENT.



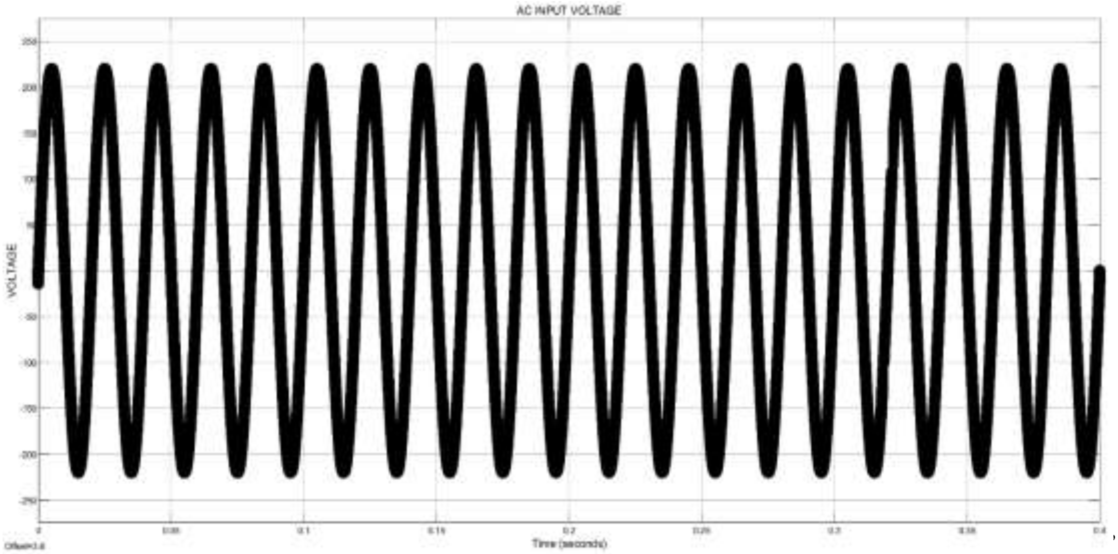
[6] PV SIDE INVERTER GATE PULSES



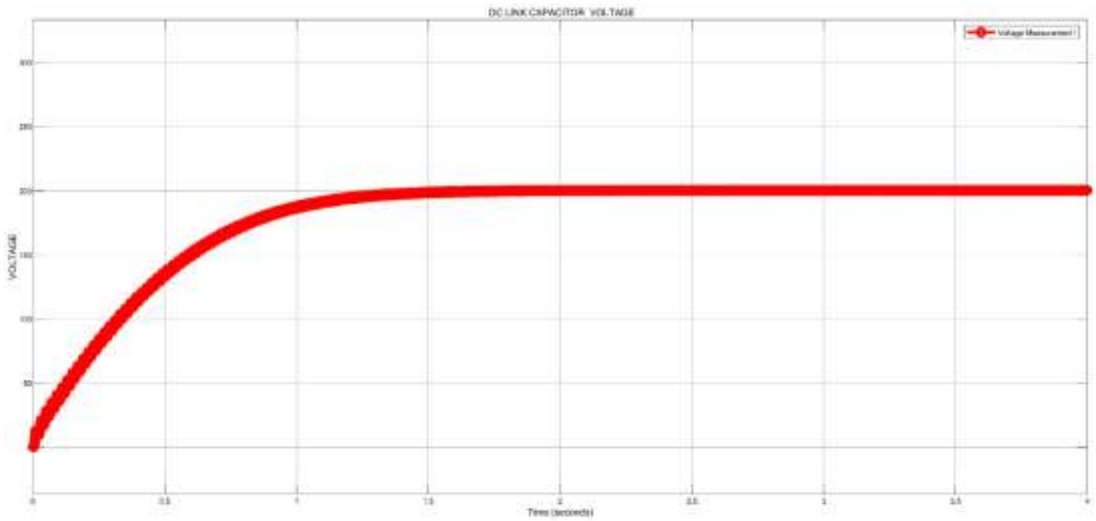
[7] PV SIDE INVERTER OUTPUT VOLTAGE



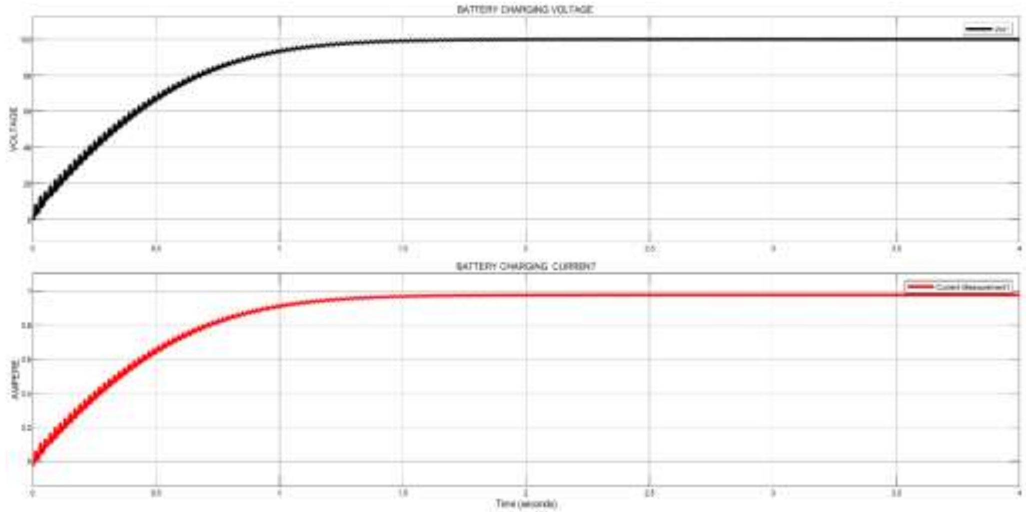
[8] AC MODE AC INPUT VOLTAGE



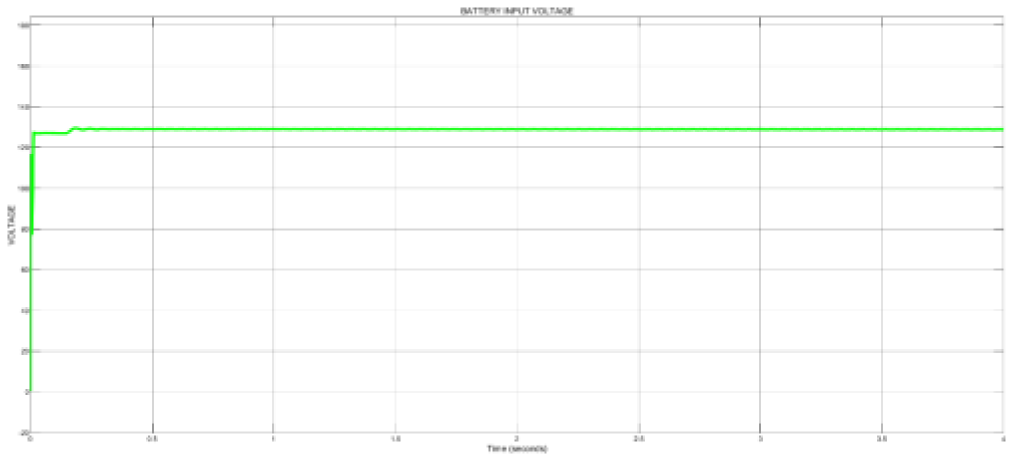
[9] AC MODE DC LINK CAPACITOR VOLTAGE



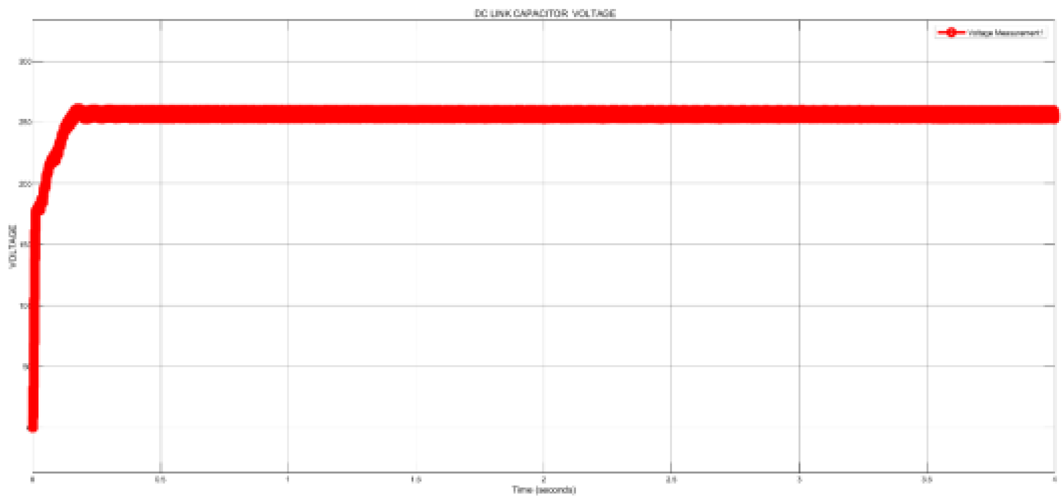
[10] AC MODE BATTERY CHARGING VOLTAGE



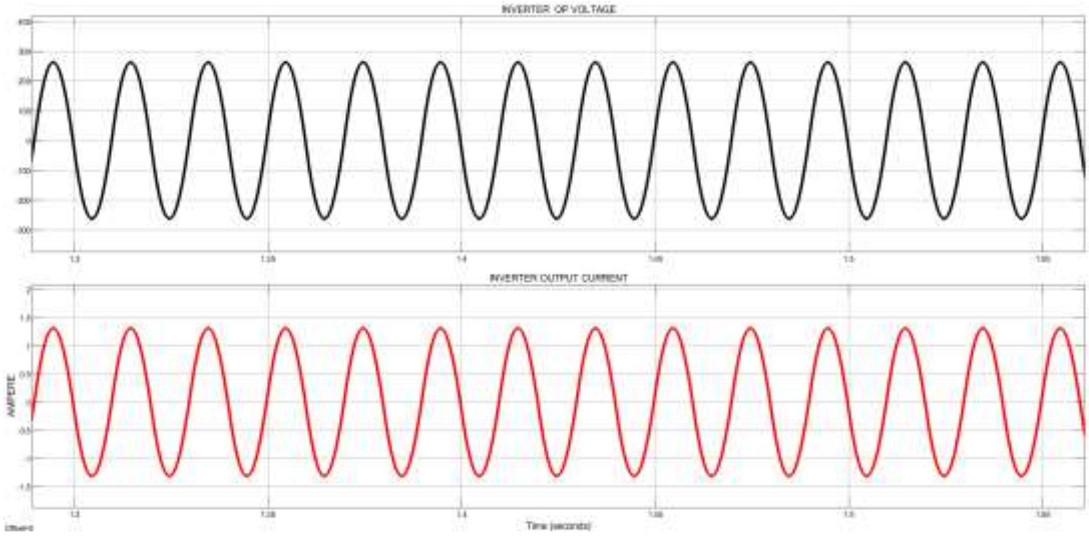
[11] BATTERY MODE BATTERY INPUT VOLTAGE



[12] BATTERY MODE DC LINK CAPACITOR VOLTAGE



[13] BATTERY MODE INVERTER OUTPUT VOLTAGE AND OUTPUT CURRENT



IV. SIMULATION DESCRIPTION

• When the solar panel is functioning, the AC supply is cut off, the PV panel generates power, which is then sent to a single-phase inverter to convert it to AC. Any extra energy is then stored in the battery.

• The next phase will turn off the solar power, use an AC source to power the inverter, convert any excess energy into DC using a rectifier, and store it in a battery.The battery is the last and only operational mode; in this case, the battery powers the inverter when the other two sources are unavailable.

V. CONCLUSION

A major step toward creating a more resilient and sustainable energy future is the development and application of hybrid AC and solar inverters. We have seen the convergence of conventional AC power systems and renewable energy sources, such as solar power, thanks to this technology, which allows for seamless integration into the current infrastructure and provides various advantages to both users and the environment. Whether off-grid or grid-tied, hybrid air conditioning and solar inverters offer a flexible way to reliably and efficiently capture solar energy. These inverters enable the integration of solar energy into homes, businesses, and communities, thereby lowering reliance on fossil fuels and mitigating greenhouse gas emissions. They do this by converting DC electricity generated by solar panels into useful AC power.The intelligent management of energy flow, which enables grid interaction and optimal solar energy utilization, is one of the main benefits of hybrid air conditioning and solar inverters. These inverters can seamlessly switch between grid-tied and standalone operation modes as needed, store excess energy in batteries for later use, and prioritize solar energy consumption through advanced control algorithms. By offering backup power during grid outages, this flexibility not only maximizes energy self-sufficiency but also improves grid stability and resilience.

FUTURE SCOPE

More advanced artificial intelligence (AI) and energy management algorithms are probably going to be included in future solar and AC inverters. These developments will allow for the real-time optimization of energy distribution, storage, and utilization while taking customer preferences, weather forecasts, and energy demand trends into account. As renewable energy sources become more widely used, inverters of the future will prioritize enhancing their grid integration capabilities. This involves enabling peer-to-peer energy trading within microgrids or virtual power plants, supporting bidirectional power flow, and offering grid support services like frequency management and voltage control.

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