EXPERIMENT ANALYSIS OF RENEWABLE ENERGY SOURCE FED BATTERY STORAGE SYSTEM FOR VEHICLE TO GRID APPLICATION USING AI TECHNIQUES

A PROJECT REPORT

Submitted by

DINESH KUMAR V	**(20BEE4016)**
JEEVA M	**(20BEE4024)**
KATHIRAVAN KS	**(20BEE4030)**
BARATHIRAJA B	**(20BEE4303)**

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of

BACHELOR OF ENGINEERING

in

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M.KUMARASAMY COLLEGE OF ENGINEERING

(Autonomous Institution affiliated to Anna University, Chennai)

BONAFIDE CERTIFICATE

Certified that this project report “EXPERIMENT ANALYSIS OF RENEWABLE ENERGY SOURCE FED BATTERY STORAGE SYSTEM FOR VECHICLE TO GRID APPLICATION USING AI TECHNIQUES” is the bonafide work of **“DINESH KUMAR V (20BEE4016), JEEVA M (20BEE4024), KATHIRAVAN KS (20BEE4030), BARATHIRAJA B (20BEE4303)** who carried out the project work during the academicyear 2023-2024 under my supervision. Certified further, that to the best of my knowledge the work reported herein does not form part of any other project report or dissertation on the basis of which a degree or award was conferred on an earlier occasion on this or any other candidate.

HEAD OF THE DEPARTMENT	**SUPERVISOR**
Dr. J. UMA M.E., Ph.D.,	Dr. S. Sathish Kumar, M.E., Ph.D.
Professor & Head,	Associate Professor,
Department of Electrical and	Department of Electrical and
Electronics Engineering,	Electronic Engineering,
M.Kumarasamy College of Engineering,	M.Kumarasamy College of Engineering,
Thalavapalayam, Karur-639113.	Thalavapalayam, Karur-639113.

This Project Work II (18EEP402L) has been submitted for the End Semester Project viva voce Examination held on _____________

INTERNAL EXAMINER **EXTERNAL EXAMINER**

DECLARATION

We affirm that the Project report titled "**EXPERIMENT ANALYSIS OF RENEWABLE ENERGY SOURCE FED BATTERY STORAGE SYSTEM FOR VECHICLE TO GRID APPLICATION USING AI TECHNIQUES"** being submitted in partial fulfillment for the award of **Bachelor of Engineering** in **Electrical and Electronics Engineering**, is the original work carried out by us. It has not formed the part of any other project report or dissertation on the basis of which a degree or award was conferred on an earlier occasion on this or any other candidate.

		Signature
DINESH KUMAR V	**(20BEE4016)**	______________
JEEVA M	**(20BEE4024)**	______________
KATHIRAVAN KS	**(20BEE4030)**	______________
BARATHIRAJA B	**(20BEE4303)**	______________

I certify that the declaration made above by the candidates is true to the best of my knowledge.

Dr. S. Sathish Kumar, M.E., Ph.D.
(Supervisor)

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PEO4: Graduates will practice ethics and have habit of continuous learning for their success in the chosen career.

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- **PO1: Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

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- **PO9: Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

- **PO10: Communication:** Communicate effectively on complex engineering activities with the engineering community, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

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PSO2: Apply relevant models, resources and emerging tools and techniques to provide solutions to power and energy related issues & challenges.

PSO3: Design, Develop and implement methods and concepts to facilitate solutions for electrical and electronics engineering related real world problems.

Abstract (key words)	POs mapping
MPPT, V2G, G2V, PV, AI, EV	PO1, PO2, PO3, PO4, PO5, PO6,PO7, PO8, PO9, PO10, PO11, PO12, PSO1, PSO2,PSO3

ABSTRACT

The demand for renewable energy sources and the promotion of electric vehicles have increased in recent years due to environmental concerns and the need for energy-efficient solutions. In line with this, a new concept called Estimation Analysis of renewable energy source-fed battery storage system for vehicle-to-grid application has emerged. This system aims to utilize a combination of solar energy, ultra-capacitors, DC to DC converters, batteries, inverters, MPPT, PIC controllers, and a grid connection to efficiently manage and store energy generated by renewable sources. To optimize the performance of this system, artificial intelligence (AI) techniques are incorporated, making it Estimation Analysis of AI-based renewable energy system. This system not only provides reliable and cost-effective energy solutions but also allows the flow of energy between the grid and electrical vehicles, enabling vehicle-to-grid (V2G) applications. For vehicle-to-grid (V2G) applications, this article offers a revolutionary integration strategy that combines artificial intelligence algorithms, battery storage systems, and renewable energy sources. In order to improve system dependability, the suggested system combines solar energy as the main input and takes use of their complimentary generation patterns. With the help of artificial intelligence algorithms, an energy management system properly regulates the flow of energy inside the system, guaranteeing effective usage and a flawless V2G functioning. In this proposed system the output value of the solar panel on the closed loop condition will be 7.10V will be efficient compare to the existing method and the output voltage of the Inverter is 3.80V will be efficient by using PIC Microcontroller as the input value will be 100 mV.

KEYWORDS: MPPT, V2G, G2V, PV, AI, EV

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LIST OF ABBREVIATION

S. No	EXPANSION	ABREVIATION
1	Vehicle to Grid	V2G
2	Maximum Power Point Tracking	MPPT
3	Photovoltaic Cell	PVC
4	Grid to Vehicle	G2V
5	Electric Double -Layer Capacitor	EDLC
6	Peripheral Interface Controller	PIC

CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

In avoiding PV specialized converter, the suggested system provides a cost-effective option for merging PV and grid. The suggested arrangement injects PV power into the grid via the generator's grid and rotor side converters. Sajad Najafi Shad. S (s.et.al.2020)[1].In optimizing the capacity of a In a solar generating system, a hybrid energy storage station , the key is to efficiently harness both wind and solar energy while minimizing waste. Optimizing the investment and operational expenses by appropriately allocating HESS capacity in response to load demand is an optimization conundrum. Tianpei Zhou (s.et.al)[2].The integration of V2G technology will optimize and utilization the clean energy will enhance its grid connectivity, while concurrently facilitating micro grids in close proximity or integrating renewable power sources into a larger network to mitigate their inherent fluctuations. R. Shi (s.et.al.2020)[3].The costs and benefits of the participants, which included power plants, grid providers, and owners of electric vehicles, were examined when four different brands of electric vehicles participated in V2G peak shaving services, been examined. X. Li (s.et.al.2020)[4].As the quantity of plug-in electric vehicles (PEVs) grows at a rapid pace, it is imperative to consider their potential application in electric power dispatch. This involves navigating numerous conflicting and competing objectives, including but not limited to delivering vehicle-to-grid connectivity and wind power cooperation. X. Zhang (s.et.al.2020)[5].They will examine how the charging and discharging patterns of electric vehicles, as well as demand side response resources, affect the economic functioning of a photovoltaic grid-connected micro grid system. The model incorporates transferable loads, electric cars, and other distributed generating technologies (such energy storage devices and diesel engines), while prioritizing three objectives: comprehensive operating costs for the micro grid; utilization rates for photovoltaic energy; and power fluctuations between the micro grid and main grid. H. Hou (s.et.al.2020)[6].In order to reduce inter-area oscillations in a power system that uses a BESS (Battery Energy Storage System), an ANN controller was proposed. Linear models have been used to produce traditional lead-lag controller-based PSSs (Power System Stabilizers). That are typically realized under high load circumstances. Because ANNs can simulate nonlinear dynamics, this research presents a nonlinear ANN-based BESS controller Lee H (s.et.al.2019)[7].An efficient A hybrid wind-photovoltaic system that uses the least amount of converters and features battery energy storage has been created. By eliminating the PV specialized converter, the suggested system provides a cost-effective option for merging PV and grid. The suggested arrangement injects PV power into the grid via the generator's grid and rotor side converters Najafi-Shad. S. (s.et.al.2020)[8].This research proposes an analytical framework for investigating the Hybrid Energy Storage Systems (HESS) for Grid Ancillary Services: Techno-economic Sustainability. For the recently established enhance frequency response (EFR) service, for instance, Li-ion batteries and super capacitors (SC) based HESS are being investigated to improve grid stability in the United Kingdom. The goal that will increase shared capacity storage units in order to lengthen battery lifespan and maximize economic advantages Bahloul, M., (s.et.al.2020)[9].In order to achieve the net-zero emissions, the aim of decreasing emissions to mitigate the detrimental effects due to climate change evolved as a goal among the participants in the worldwide communication. Hannan, M., (s.et.al.2021)[10].In a solar hybrid power generating device of a super capacitor hybrid energy storage system may significantly enhance the capacity for system energy storage and output power. This study integrates the distributed power generating system with the hybrid energy storage technology, while employing the conductance-fuzzy dual-mode control technique and the static reactive power compensation system to gradually increase output power. Zhu, R., (s,et.al.2020)[11].According to actual energy consumption statistics and simulations, Combining fixed battery and mobile hydrogen vehicle storage with hybrid renewable energy systems to create a zero-energy town including office, residential, and college facilities. Liu, J., (s.et.al.2021)[12].Integration and development of (BESS) and (RESs) have driven extensive research and development Wali, S., (s.et.al.2020)[13].A hybrid photovoltaic-battery energy storage system that participates in a balancing group that submits a shared scheduling unit to the day-ahead market and declares its hourly generating rates. It also looks at how unpredictable solar system generation is and how energy storage responds to it. Whether a hybrid photovoltaic-battery energy storage system is technically and economically feasible, as well as how to scale battery energy storage for that purpose, were the primary research questions. Małkowski, R. (s.et.al.2020)[14].In a tan average residential high-rise, a comprehensive Energy planning approach combining battery and hydrogen vehicle storage technologies with hybrid solar and wind energy systems taking into account diverse vehicle-to-building schedules. To scale the hybrid system and select the most effective energy control technique, many design factors are used, including Grid integration, supply performance, and lifetime net present value. Liu, J., (s.et.al.2021)[15].The wind-solar hybrid power system (WSHPS) uses a battery and super-capacitor hybrid energy storage subsystem (HESS) with an hourly dispatching period for the whole day. Frequency management is employed in the HESS design to extend battery life by using the high energy density characteristic of batteries and the high power density feature of super-capacitors. Roy, P., (s.et.al.2020)[16].Energy storage technology is unquestionably gaining an underpinning function It acting as the technology that makes intermittent renewable energy systems with solar and wind power production long-term reliable. Li-ion batteries for electrical storage and fuel cells and electrolytes for hydrogen storage are two potential possibilities for quick load leveling response Zhang, Y., (s.et.al.2020)[17].Utilizing one or more control approaches, an energy management system is utilized to sense, monitor, and regulate the actions of hybrid energy sources. Reducing hydrogen consumption and optimizing the state of charge of batteries are the main objectives of renewable hybrid power systems that use fuel cells utilization. These factors will be the critical for maximizing an benefits of cost reduction and battery and hydrogen storage lifespan extension Kamel, A., (s.et.al.2020)[18].The proposed The hybrid renewable energy system was developed as a multi-converter system that included a photovoltaic array and battery energy system in addition to a gear-less wind turbine-powered permanent magnet synchronous generator. Gajewski, P., (s.et.al.2020)[19].Power electronic converters are critical components of the system since they maximize the various sources' methods to control and energy management. The speed of Single Input Fuzzy Logic (SIFL) controllers are utilized in the wind and solar subsystems, will collect the maximum power point tracking . Benlahbib, B., (s,et.al.2020)[20].

CHAPTER 2

LITERATURE SURVEY

2.1TITLE: Fair Management of Vehicle-to-Grid and Demand Programs in Local Energy

AUTHOR: Catia Silva and Pedro Faria

YEAR: 2023

DESCRIPTION:

Electric Vehicles (EV) are emerging in electricity grid, where the Vehicle-to-Grid (V2G) feature is a major flexibility opportunity for Demand Response (DR) programs. Optimized and fair management of EVs flexibility activation is then required. In the present paper it is proposed a methodology to deal with the complex management of the Local Energy Communities (LEC) with such resources. The method allows the fair selection of DR and V2G participants.

2.2 TITLE: A Quantitative Method to Assess the Vehicle-To-Grid Feasibility of the Local Public Transport Company

AUTHOR: Fabio Borghetti and Micchela Londgo

Year: 2023

DESCRIPTION:

In this paper, a quantitative model is implemented with the main goal of building a decision support tool to assess the feasibility of applying a Vehicle-To-Grid (V2G) service by a company operating a fleet of electric buses. The proposed model can calculate the energy that a vehicle within a depot can deliver back to the grid during periods of peak energy demand, based on the operational schedule that must be guaranteed (number of buses in service).

2.3 TITLE: Reaping the Benefits of Smart Electric Vehicle Charging and Vehicle-to-Grid Technologies

AUTHOR: Sridevi Tirunagari and Mingchen

YEAR: 2021

DESCRIPTION:

Electric vehicles (EVs) are penetrating rapidly into the transport sector while making profound impact on the electricity and energy sectors. Although EVs have many benefits, it poses several challenges to power grid operators. Uncoordinated EV charging is one of the critical issues that need to be addressed to mitigate the potential adverse effects on power grids.

2.4 TITLE: Multiple group search optimization based on decomposition for multi-objective dispatch with electric vehicle and wind power uncertainties

AUTHOR: X. Zhang, K. W. Chan, H. Wang, B. Zhou, G. Wang, and J. Qiu

YEAR: 2020

DESCRIPTION:

Polarization shaped terahertz sources play a key factor in terahertz wireless communications, biological sensing, imaging, coherent control in fundamental sciences, and so on. Recently developed introspect terahertz emitters have been considered as one of the next-generation promising high performance broadband terahertz sources. However, until now, polarization control, especially for twisting the circularly polarized terahertz waves at the introspect terahertz source, has not yet been systematically explored and experimentally achieved. In this work, we not only demonstrate the generation of circularly polarized terahertz waves in cascade introspect terahertz emitters via delicately engineering the amplitudes, applied magnetic field directions, and phase differences in two-stage terahertz beams but also implement the manipulation of the centrality, azimuth angle, and elliptical of the radiated broadband terahertz waves. We believe our work can help with further understanding of the ultra fast optical magnetic physics and may have valuable contributions for developing advance terahertz sources and opt introspect devices.

2.5 TITLE: Multiobjective economic dispatch of microgrid considering electric vehicle and transferable load

AUTHOR: H. Hou, M. Xue, Y. Xu, Z. Xiao, X. Deng, T. Xu, P. Liu and R. Cui

YEAR: 2020

DESCRIPTION:

In order to investigate the impact of electric vehicles' charging-discharging behaviour and demand side response resources on the economic operation of photovoltaic grid-connected microgrid system, a multi-objective model of microgrid economic dispatching with electric vehicles, transferable load and other distributed generations (diesel engines and energy storage unit) is proposed in this paper. The model takes the comprehensive operating cost of microgrid, the utilization rate of photovoltaic energy and the power fluctuation between the microgrid and main grid as objectives. Moreover, four different cases of microgrid economic dispatch considering electric vehicles and transferable load are put forward, which are electric vehicles' orderly charging and discharging and transferable load participating in demand response in Case 1, electric vehicles' charging randomly and the transferable load participating in demand response in Case 2, electric vehicles orderly charging and discharging and transferable load not participating in demand response in Case 3, electric vehicles' charging randomly and the transferable load not participating in the demand response in Case 4. Multi-objective Seeker Optimization Algorithm and the method of fuzzy membership function are applied in this study to obtain the optimal results. The simulation analysis shows that the orderly charging-discharging behaviour of electric vehicles and the participation of transferable load can effectively improve the economic costs, efficiency and security of microgrid economic operation.

2.6 TITLE: Artificial Neural Network Control of Battery Energy Storage System to Damp-Out Inter-Area Oscillations in Power Systems

AUTHOR: Lee, H., Jhang, S., Yu, W., And Oh, J

YEAR:2019

DESCRIPTION:

This paper proposed an ANN (Artificial Neural Network) controller to damp out inter-area oscillation of a power system using BESS (Battery Energy Storage System). The conventional lead-lag controller-based PSSs (Power System Stabilizer) have been designed using linear models usually linearized at heavy load conditions. This paper proposes a non-linear ANN based BESS controller as the ANN can emulate nonlinear dynamics. To prove the performance of this nonlinear PSS, two linear PSS are introduced at first which are linearized at the heavy load and light load conditions, respectively. It is then verified that each controller can damp out inter-area oscillations at its own condition but not satisfactorily at the other condition. Finally, an ANN controller, that learned the dynamics of these two controllers, is proposed. Case studies are performed using PSCAD/EMTDC and MATLAB. As a result, the proposed ANN PSS shows a promising robust nonlinear performance.

2.7 TITLE: An Energy Storage Performance Improvement Model for Grid-Connected Wind-Solar Hybrid Energy Storage System

AUTHOR: Zhu, R., Zhao, A., Wang, G., Xia, X., & Yang, Y

YEAR:2020

DESCRIPTION:

This study introduces a supercapacitor hybrid energy storage system in a wind-solar hybrid power generation system, which can remarkably increase the energy storage capacity and output power of the system. In the specific solution, this study combines the distributed power generation system and the hybrid energy storage system, while using the static reactive power compensation system and the conductance-fuzzy dual-mode control method to increase output power in stages. At the same time, the optimal configuration model of the wind-solar hybrid power generation system is established using MATLAB/Simulink software. The output power of the microgrid to the wind-photovoltaic hybrid power generation system is calculated by simulation, and the optimization process of each component of the system is simulated. This study mainly uses the static reactive power compensation system and the conductance-fuzzy dual-mode control method to optimize the wind-solar hybrid power generation system. Using MATLAB software simulation verifies the feasibility and rationality of the optimal configuration of the system.

2.8 TITLE: An effective hybrid wind-photovoltaic system including battery energy storage with reducing control loops and omitting PV converter

AUTHOR: Najafi-Shad, S., Barakati, S., & Yazdani, A

YEAR:2020

DESCRIPTION:

In this paper, an effective hybrid wind-photovoltaic system including battery energy storage system with an optimal number of converters has been introduced. The proposed system provides an economical solution for combining PV and grid by removing the PV dedicated converter. The proposed configuration uses both the grid side and rotor side converters of the generator to inject PV power into the grid. So, it is also able to inject PV power into the network more efficiently compared with the conventional systems. The complementary profiles of solar radiation and wind energy considerably improves the converters utilization. Moreover, by means of the embedded energy storage, the impact of intermittency of wind and radiation has been significantly reduced in the proposed system. Additionally, even though the converter typically dedicated to PV systems has been dispensed with, the PV system operates with a maximum power point tracking (MPPT) strategy.

CHAPTER 3

EXISTING SYSTEM

3.1 INTRODUCTION

The increasing demand for renewable energy sources, coupled with the growing popularity of electric vehicles, has created a need for innovative solutions that can effectively manage and store energy generated from these sources. In response to this demand, a new concept called a renewable energy source-fed battery storage system for vehicle-to-grid application has emerged. This system combines the use of renewable energy sources, advanced energy storage technologies, and artificial intelligence techniques to provide efficient and sustainable energy solutions.

3.2 BLOCK DIAGRAM

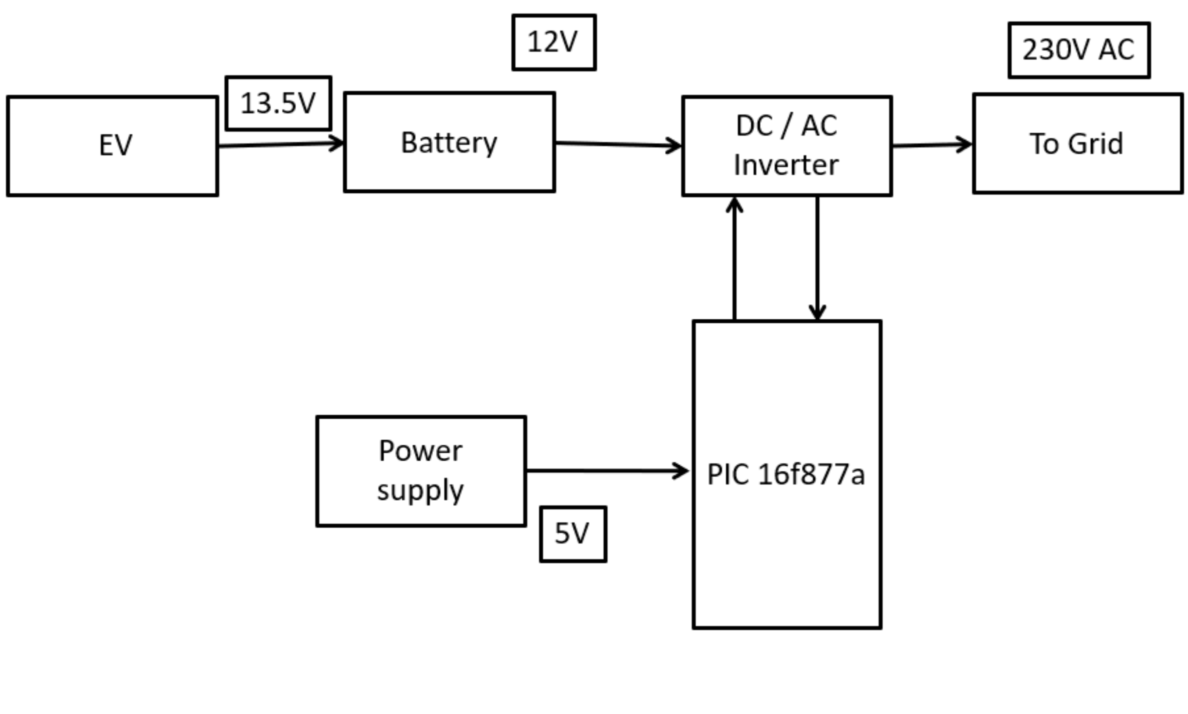

Figure 3.1 Block diagram of Existing Method of HRSS

Figure 3.1 will say about the block diagram of Existing Method of HRSS, we obtain the energy source from the grid to charge the Electric Vehicle (EV) battery and invert the supply back to the grid. This process is known as Vehicle-to-Grid (V2G), which involves transferring power stored in EV batteries by utilizing an inverter to payback to the grid. The transformer connects the grid's power supply to the load, which then passes it on to the Converter. This device converts the AC supply into a DC supply that can be stored in the Electric Vehicle Battery. The battery has a capacity of 12V and feeds into an inverter that uses a rectifier to convert DC back into AC for feedback to the grid. This process is known as Vehicle-to-Grid (V2G). The PIC Micro Controller controls and maintains application, with an input supply of 5V.

3.3 SUMMARY

V2G is a technology that allows Electric vehicles (EVs) to discharge energy from their batteries back into the electrical grid. When EVs are plugged in, they can send excess electricity stored in their batteries to the grid during periods of high demand. This can help stabilize the grid and provide additional power during peak load times.G2V is the process of charging an electric vehicle's battery from the electrical grid. EV owners connect their vehicles to the grid to recharge their batteries. Charging can occur at various locations, including homes, workplaces, and public charging stations.

CHAPTER 4

PROPOSED SYSTEM

4.1 INTRODUCTION

The Renewable Energy Source fed Battery Storage System for Vehicle to Grid Application Using AI Technology is a system that combines renewable energy sources, battery storage, and artificial intelligence technology. They are used to manage energy demand between a microgrid, a solar photovoltaic (SPV) unit, and electric vehicles (EVs) in real-time. The system includes a Home Energy Management System (HEMS) storage device (batteries) and a Vehicle-to-Home unit (V2H) that can make decisions, compare parameters, send real-time data, and send feedback about the system and consumption, making the energy management process intelligent. This system aims to address the challenges of conventional electrical grids, including the inability to fulfil peak demand, expensive power outages, and pollution-induced environmental catastrophes. The integration of renewable energy sources and electric vehicles into the grid is based on research into cutting-edge smart metering and communication systems. The use of artificial intelligence promises battery life cycle data monitoring and enables the efficient management of renewable energy sources.

4.2 BLOCK DIAGRAM

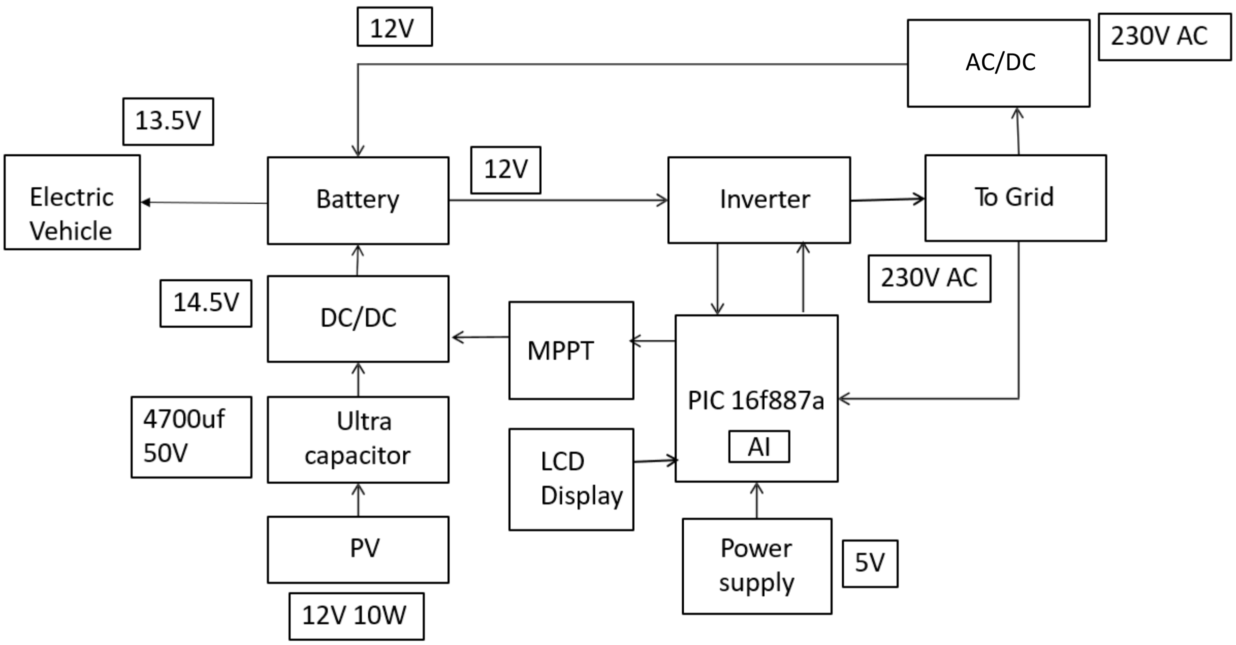

Figure 4.1 Block diagram of Proposed Method

4.2.1 Electric Vehicle

Electric vehicles (EVs) are a type of automotive vehicle that is powered by electricity instead of traditional internal combustion engines fueled by gasoline or diesel. They are a more environmentally friendly and energy-efficient mode of transportation, offering several advantages

1. Zero Emissions: Electric vehicles produce no tailpipe emissions, reducing air pollution and contributing to better air quality, especially in urban areas. This is essential for combating climate change and improving public health.

2. Energy Efficiency: Electric vehicles are more energy-efficient than traditional gasoline-powered vehicles. They convert a higher percentage of the

electrical energy from the grid to power at the wheels, resulting in lower energy consumption.

3. Lower Operating Costs: EVs have fewer moving parts than conventional vehicles, reducing the need for maintenance. They also cost less to refuel since electricity is generally cheaper than gasoline. Additionally, governments may offer incentives such as tax credits and reduced registration fees.

4. Quiet and Smooth Operation: Electric vehicles are known for their quiet and smooth ride due to the absence of noisy internal combustion engines. This can contribute to a more comfortable driving experience.

5. Regenerative Braking: Many electric vehicles utilize regenerative braking systems, which recover energy during braking and convert it back into electricity to recharge the battery. This improves overall energy efficiency.

There are several types of electric vehicles, including:

1. Battery Electric Vehicles (BEVs): These run solely on electricity and are powered by rechargeable lithium-ion batteries. They need to be plugged in to charge, and they have no internal combustion engine.

2. Plug-in Electric Vehicles (PEVs): PHEVs combine an internal combustion engine with an electric motor and a battery. They can be charged via a plug and can operate in electric-only mode for a certain distance before switching to gasoline.

3. Hybrid Electric Vehicles (HEVs): HEVs have both an internal combustion engine and an electric motor, but the electric motor primarily assists the engine and cannot be charged from an external source.

4. Hydrogen Fuel Cell Vehicles (FCVs): These vehicles use a chemical process

that combines hydrogen with oxygen to produce electricity, powering an electric motor. They emit only water vapor as a byproduct.

The adoption of electric vehicles is growing as technology improves, and charging infrastructure becomes more widespread. Governments and businesses are promoting EVs to reduce greenhouse gas emissions and dependence on fossil fuels. However, challenges such as limited range, longer refueling times compared to gasoline vehicles, and the environmental impact of battery production and disposal are still being addressed as the electric vehicle market continues to evolve.

4.2.2 Battery

The battery is a crucial component of an electric vehicle (EV) as it stores and supplies the electrical energy needed to power the vehicle's electric motor. Most EVs use lithium-ion (Li-ion) batteries, although there are other types of batteries in development. Here are some key aspects of electric vehicle batteries:

1. Lithium-Ion Batteries: Lithium-ion batteries are the most common type of battery used in electric vehicles due to their high energy density, which provides a good balance between weight, capacity, and efficiency. These batteries are also widely used in consumer electronics and other applications. They consist of lithium-ion cells, and several cells are grouped together to form a battery pack.

2. Battery Capacity (kWh): The capacity of an EV battery is measured in kilowatt-hours (kWh). A higher kWh rating means the battery can store more energy and provide longer driving ranges on a single charge. Different EV

models have different battery capacities, and larger batteries generally offer greater driving ranges.

3. Charging and Discharging: EV batteries are charged by plugging the vehicle into a charging station, which provides electrical energy to the battery. During driving, the battery discharges, supplying power to the electric motor. Most EVs also have regenerative braking systems that recharge the battery when slowing down or braking.

4. Charging Speed: The time it takes to charge an EV depends on the charger's power (measured in kilowatts) and the vehicle's battery capacity. Charging can range from several hours for standard home chargers to as little as 30 minutes or less for fast-charging stations, which are becoming more common.

5. Range: The range of an EV refers to the distance it can travel on a single charge. It varies depending on the vehicle model and battery capacity. Advances in battery technology are continually increasing the range of electric vehicles.

6. Battery Degradation: Over time, all batteries experience a gradual decrease in capacity, known as battery degradation. Factors such as temperature, usage patterns, and charging habits can affect the rate of degradation. However, battery management systems in EVs help optimize charging and usage to minimize this effect.

7. Recycling and Environmental Impact: Electric vehicle batteries are recyclable, and many manufacturers have recycling programs in place to recover valuable materials like lithium, cobalt, and nickel. Proper recycling and disposal methods are essential to minimize the environmental impact of EV batteries.

8. Safety: EV batteries are designed with safety in mind. They have multiple layers of protection to prevent overheating and ensure safe operation. In the rare

event of a battery fire, emergency response protocols are in place.

9. Second-Life Applications: Some EV batteries can still have a useful life after they are no longer suitable for vehicular use. These "second-life" batteries can be repurposed for stationary energy storage applications, such as grid support or home energy storage.

As technology advances, research into battery materials and designs continues, aiming to improve energy density, reduce costs, and enhance overall performance. This progress is critical for the continued growth of the electric vehicle market and the reduction of greenhouse gas emissions in the transportation sector.

4.2.3 Inverter

The An inverter is an electrical device that is used to convert direct current (DC) power into alternating current (AC) power. It is an essential component in various applications, including solar power systems, electric vehicles, uninterruptible power supplies (UPS), and more. Inverters serve the purpose of changing the form of electrical power to make it suitable for different devices and appliances that run on AC power.

Some key points about inverters:

1. DC to AC Conversion: The primary function of an inverter is to take DC power, such as that generated by solar panels, stored in batteries, or produced by other sources, and convert it into AC power. This is crucial because most of the electrical devices and appliances we use in our daily lives operate on AC power.

2. Wave forms: Inverters can produce different types of AC waveform, with the two most common being sine waves and modified sine waves. Sine wave inverters

produce a smooth and clean waveform that closely mimics the power from the grid, making them suitable for most electronic devices. Modified sine wave inverters are less expensive but can be less suitable for sensitive equipment.

3. Applications: Solar Power Systems: Inverters are used in solar photovoltaic (PV) systems to convert the DC electricity generated by the solar panels into usable AC electricity for homes and businesses.

Electric Vehicles (EVs): In EVs, inverters are responsible for converting DC power from the vehicle's battery into the AC power required to drive the electric motor.

Backup Power: Inverters are a key component in UPS systems, which provide backup power during outages to keep critical equipment running.

Industrial Applications: Inverters are used in industrial settings to control the speed and direction of AC motors, allowing for precise control of machinery and equipment.

Off-Grid Power Systems: Inverters are also used in off-grid power systems where there is no connection to the main electrical grid. They help manage power from renewable sources (e.g., wind turbines or hydroelectric generators) and store it in batteries for use as AC power.

4. Efficiency: Inverters can have varying levels of efficiency, and it's important to select an inverter that matches the application's requirements. Higher-efficiency inverters waste less energy during the conversion process.

5. Sizing: The size of an inverter should be chosen based on the power requirements of the connected devices. In solar power systems, for example, the inverter should be appropriately sized to handle the peak power generated by the solar panels.

6. Inverter Types: There are different types of inverters, including grid-tied inverters,

off-grid inverters, microinverters, and string inverters, each designed for specific applications.

Inverters play a critical role in the efficient and reliable operation of various electrical systems, making them an integral part of modern energy management and electrical power distribution. The choice of the right inverter depends on the specific needs and characteristics of the application in which it is used.

4.2.4 DC – DC Converter

A DC-to-DC converter is an electronic circuit or electromechanical device that converts a source of direct current (DC) from one voltage level to another. It is a type of electric power converter. Power levels range from very low (small batteries) to very high (high-voltage power transmission).

Before the development of power semiconductors, one way to convert the voltage of a DC supply to a higher voltage, for low-power applications, was to convert it to AC by using a vibrator, then by a step-up transformer, and finally a rectifier. Where higher power was needed, a motor–generator unit was often used, in which an electric motor drove a generator that produced the desired voltage. (The motor and generator could be separate devices, or they could be combined into a single “dynamo-tor” unit with no external power shaft.) These relatively inefficient and expensive designs were used only when there was no alternative, as to power a car radio (which then used thermionic valves (tubes) that require much higher voltages than available from a 6 or 12 V car battery). The introduction of power semiconductors and integrated circuits made it economically viable by use of techniques described below. For example, first is converting the DC power supply to high-frequency AC as an input of a transformer – it is small, light, and cheap due to the high frequency that changes the voltage which gets rectified back to DC. Although by 1976 transistor car radio receivers did not require high voltages, some amateur radio operators continued to use vibrator supplies and dynamotors for mobile transceivers requiring high voltages although transistorized power supplies were available.

While it was possible to derive a lower voltage from a higher with a linear regulator or even a resistor, these methods dissipated the excess as heat; energy efficient conversion became possible only with solid-state switch-mode circuits.

DC-to-DC converters are used in portable electronic devices such as cellular phones and laptop computers, which are supplied with power from batteries primarily. Such electronic devices often contain several sub-circuits, each with its own voltage level requirement different from that supplied by the battery or an external supply (sometimes higher or lower than the supply voltage). Additionally, the battery voltage declines as its stored energy is drained. Switched DC to DC converters offer a method to increase voltage from a partially lowered battery voltage thereby saving space instead of using multiple batteries to accomplish the same thing.

Most DC-to-DC converter circuits also regulate the output voltage. Some exceptions include high-efficiency LED power sources, which are a kind of DC to DC converter that regulates the current through the LEDs, and simple charge pumps which double or triple the output voltage.

DC-to-DC converters which are designed to maximize the energy harvest for photovoltaic systems and for wind turbines are called power optimizers.

Transformers used for voltage conversion at mains frequencies of 50–60 Hz must be large and heavy for powers exceeding a few watts. This makes them expensive, and they are subject to energy losses in their windings and due to eddy currents in their cores. DC-to-DC techniques that use transformers or inductors work at much higher frequencies, requiring only much smaller, lighter, and cheaper wound components. Consequently, these techniques are used even where a mains transformer could be used; for example, for domestic electronic appliances it is preferable to rectify mains voltage to DC, use switch-mode techniques to convert it to high-frequency AC at the desired voltage, then, usually, rectify to DC. The entire complex circuit is cheaper and more efficient than a simple mains transformer circuit of the same output. DC-to-DC converters are widely used for DC micro grid applications, in the context of different voltage levels.

4.2.5 DC-DC CONVERTER WORKING

The **working principle** of the DC-to-DC converter is very simple. The **inductor** in the input resistance has an unexpected variation in the input current. If the switch is kept as high (on), then the inductor feeds the energy from the input and stores the energy in the form of **magnetic energy.**

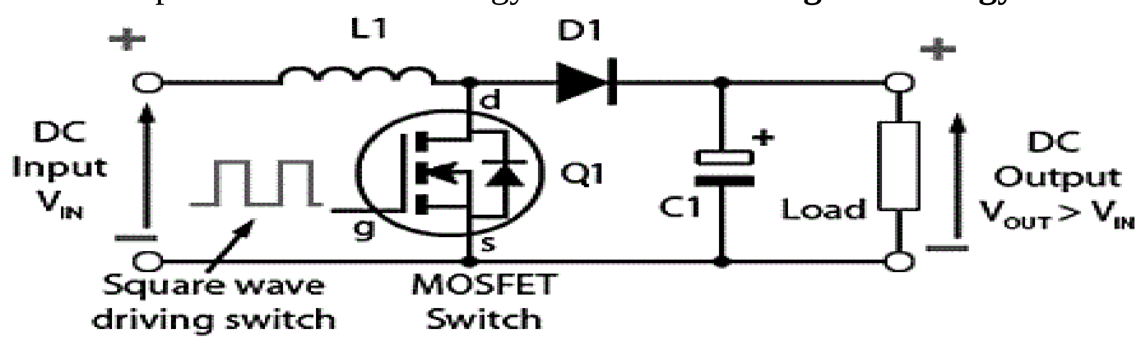

Figure 4.2 DC-DC Converter

If the switch is kept as **low (off),** it discharges the energy. Here, the output of the capacitor is assumed as **high** that is sufficient for the time constant of an **RC circuit** on the output side. The huge time constant is compared with the switching period and made sure that the steady-state is a constant output voltage. It should be *Vo(t) = Vo(constant)* and present at the load terminal.

Figure 4.3 DC-DC Boost Converter Constant Current Mobile Power Supply 10A 250W Led Driver

4.2.6 Ultra Capacitor

An ultra capacitor, also known as a super capacitor or electric double-layer capacitor (EDLC), is an energy storage device that stores and releases electrical energy. Ultra capacitors are distinct from conventional electrochemical batteries in terms of their energy storage mechanism, which involves the electrostatic separation of charged ions rather than chemical reactions. Here are some key characteristics and applications of ultra capacitors:

1. Energy Storage Mechanism: Ultra capacitors store energy by separating positive and negative charges on the surface of electrode materials. This separation of charges forms an electric double layer, and energy is stored as an electrostatic field. This mechanism allows for rapid charge and discharge cycles.

2. High Power Density: Ultra capacitors are known for their high-power density, meaning they can deliver a large amount of electrical power quickly. This makes them ideal for applications that require bursts of power, such as hybrid and electric vehicles (EVs) for regenerative braking and quick acceleration.

3. Quick Charge and Discharge: Unlike batteries, which can take hours to charge and discharge, ultra capacitors can be charged and discharged very quickly, often in a matter of seconds. This rapid response time is one of their key advantages.

4. Long Cycle Life: Ultra capacitors have a much longer cycle life compared to most batteries, often lasting hundreds of thousands of charge and discharge cycles. This durability is a valuable feature for applications with frequent cycling.

5. Low Energy Density: While ultra capacitors excel in terms of power density and cycle life, they have a lower energy density compared to batteries. This means they can store less total energy for a given volume or weight. Consequently, they are typically used in conjunction with batteries or other energy storage technologies to complement their capabilities.

6. Super capacitor Applications:

- Automotive: Ultra capacitors are used in hybrid and electric vehicles to capture and store energy during regenerative braking, providing quick bursts of power for acceleration. They can also enhance battery life and provide backup power for engine starting.

- Renewable Energy: Ultra capacitors are employed in wind turbine pitch control systems and solar power inverters to provide short-term energy storage and power smoothing.

- Consumer Electronics: Some small-scale devices, like digital cameras and portable electronic gadgets, use ultra capacitors for quick energy storage and release.

- Industrial and Transportation: They can be used in applications that require high-power bursts, like elevators, cranes, and public transportation systems.

-Backup Power: Ultra capacitors can provide short-term backup power in case of power outages, ensuring continuity of critical processes.

Ultra capacitors are particularly valuable in situations where rapid, high-power performance is essential. However, their lower energy density makes them less suitable for applications requiring long-term energy storage, where conventional batteries are more appropriate. Researchers continue to work on improving ultra capacitor technology to increase their energy density and expand their range of applications.

4.2.6 Solar Panel (Photovoltaic Module)

A solar cell panel, solar electric panel, photo-voltaic (PV) module or solar panel is an assembly of photo-voltaic cells mounted in a framework for installation Solar panels use sunlight as a source of energy to generate direct current electricity. A collection of PV modules is called a PV panel, and a system of PV panels is called an array. Arrays of a photovoltaic system supply solar electricity to electrical equipment.

Figure 4.4 Solar Panel (Photovoltaic Module)

Construction of Photovoltaic modules use light energy (photons) from the Sun to generate electricity through the photovoltaic effect. Most modules use wafer-based crystalline silicon cells or thin-film cells. The structural (load carrying) member of a module can be either the top layer or the back layer. Cells must be protected from mechanical damage and moisture. Most modules are rigid, but semi-flexible ones based on thin-film cells are also available. The cells are usually connected electrically in series, one to another to the desired voltage, and then in parallel to increase current. The power (in watts) of the module is the mathematical product of the voltage (in volts) and the current (in amperes) of the module. The manufacturing specifications on solar panels are obtained under standard condition, which is not the real operating condition the solar panels are exposed to on the installation site.

A PV junction box is attached to the back of the solar panel and functions as its output interface. External connections for most photovoltaic modules use MC4 connectors to facilitate easy weatherproof connections to the rest of the system. A USB power interface can also be used.

Solar panels also use metal frames consisting of racking components, brackets, reflector shapes and troughs to better support the panel structure..

Arrays of PV modules: A single solar module can produce only a limited amount of power; most installations contain multiple modules adding voltages or current to the wiring and PV system. A photovoltaic system typically includes an array of photovoltaic modules, an inverter, a battery pack for energy storage, charge controller, interconnection wiring, circuit breakers, fuses, disconnect switches, voltage meters, and optionally a solar tracking mechanism. Equipment is carefully selected to optimize output, energy storage, reduce power loss during power transmission, and conversion from direct current to alternating current.

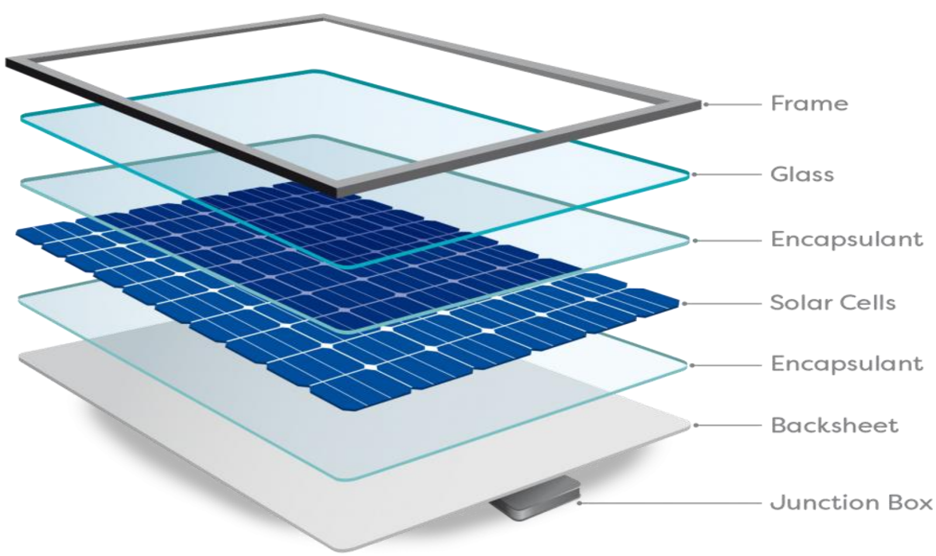

Figure 4.5 Layout of Solar Panel

4.2.7 Maximum Power Point Tracking (MPPT)

Maximum Power Point Tracking, frequently referred to as MPPT, is an electronic system that operates the Photovoltaic (PV) modules in a manner that allows the modules to produce all the power they are capable of. MPPT is not a mechanical tracking system that “physically moves” the modules to make them point more directly at the sun. MPPT is a fully electronic system that varies the electrical operating point of the modules so that the modules are able to deliver maximum available power. Additional power harvested from the modules is then made available as increased battery charge current. MPPT can be used in conjunction with a mechanical tracking system, but the two systems are completely different.
To understand how MPPT works, let’s first consider the operation of a conventional (non- MPPT) charge controller. When a conventional controller is charging a discharged battery, it simply connects the modules directly to the battery. This forces the modules to operate at battery voltage, typically not the ideal operating voltage at which the modules are able to produce their maximum available power. The PV Module Power/Voltage/Current graph shows the traditional Current/Voltage curve for a typical 75W module at standard test conditions of $25^{\circ}C$ cell temperature and $1000W/m^2$ of insolation. This graph also shows PV module power delivered vs module voltage. For the example shown, the conventional controller simply connects the module to the battery and therefore forces the module to operate at 12V. By forcing the 75W module to operate at 12V the conventional controller artificially limits power production to 53W.

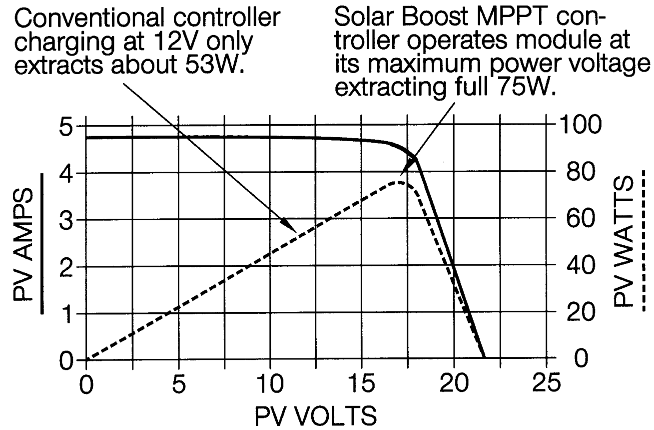

Figure 4.6 Typical 75W PV Module Power/Voltage/Current at Standard Test Conditions

Rather than simply connecting the module to the battery, the patented MPPT system in a Solar Boost™ charge controller calculates the voltage at which the module is able to produce maximum power. In this example the maximum power voltage of the module (V_{MP}) is 17V. The MPPT system then operates the modules at 17V to extract the full 75W, regardless of present battery voltage. A high efficiency DC-to-DC power converter converts the 17V module voltage at the controller input to battery voltage at the output. If the whole system wiring and all was 100% efficient, battery charge current in this example would be V_{MODULE} □ $V_{BATTERY}$ x I_{MODULE}, or 17V □ 12V x 4.45A = 6.30A. A charge current increase of 1.85A or 42% would be achieved by harvesting module power that would have been left behind by a conventional controller and turning it into useable charge current. But, nothing is 100% efficient and actual charge current increase will be somewhat lower as some power is lost in wiring, fuses, circuit breakers, and in the Solar Boost charge controller. Actual charge current increase varies with operating conditions.

As shown above, the greater the difference between PV module maximum power voltage V_{MP} and battery voltage, the greater the charge current increase will be. Cooler PV module cell temperatures tend to produce higher V_{MP} and therefore greater charge current increase. This is because V_{MP} and available power increase as module cell temperature decreases as shown in the PV Module Temperature Performance graph. Modules with a 25□C V_{MP} rating higher than 17V will also tend to produce more charge current increase because the difference between actual V_{MP} and battery voltage will be greater. A highly discharged battery will also increase charge current since battery voltage is lower, and output to the battery during MPPT could be thought of as being "constant power".

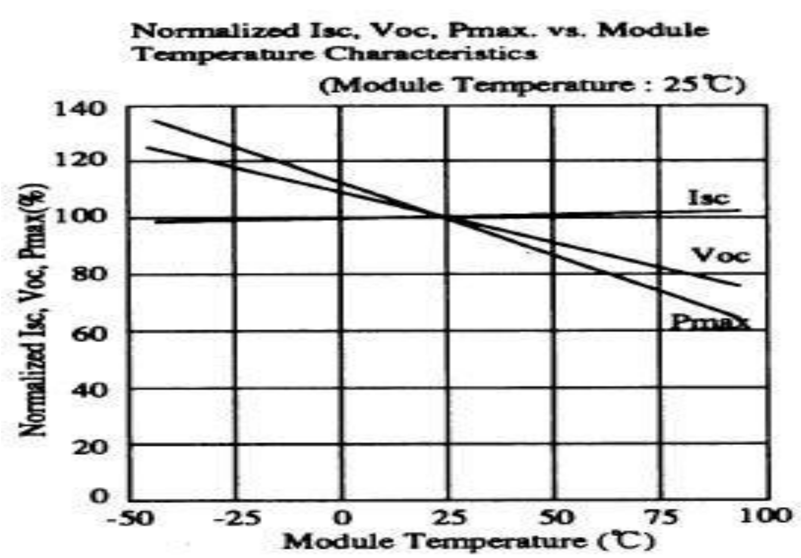

Figure 4.7. Typical PV Module Temperature Performance

What most people see in cool comfortable temperatures with typical battery conditions is a charge current increase of between 10 – 25%. Cooler temperatures and highly discharged batteries can produce increases in excess of 30%. Customers in cold climates have reported charge current increases in excess of 40%. What this means is that current increase tends to be greatest when it is needed most; in cooler conditions when days are short, sun is low on the horizon, and batteries may be more highly discharged. In conditions where extra power is not available (highly charged battery and hot PV modules) a Solar Boost charge controller will perform as a conventional PWM type controller.

4.3.8 PIC Microcontroller

PIC is a family of modified Harvard architecture micro controllers made by Microchip Technology, derived from the PIC1650 originally developed by General Instrument's Microelectronics Division. The name PIC initially referred to "Peripheral Interface Controller" now it is "PIC" only.

Figure 4.8 PIC Microcontroller (PIC 16F877A)

PICs are popular with both industrial developers and hobbyists alike due to their low cost, wide availability, large user base, extensive collection of application notes, availability of low cost or free development tools, and serial programming (and re-programming with flash memory) capability.

4.3 Circuit Diagram

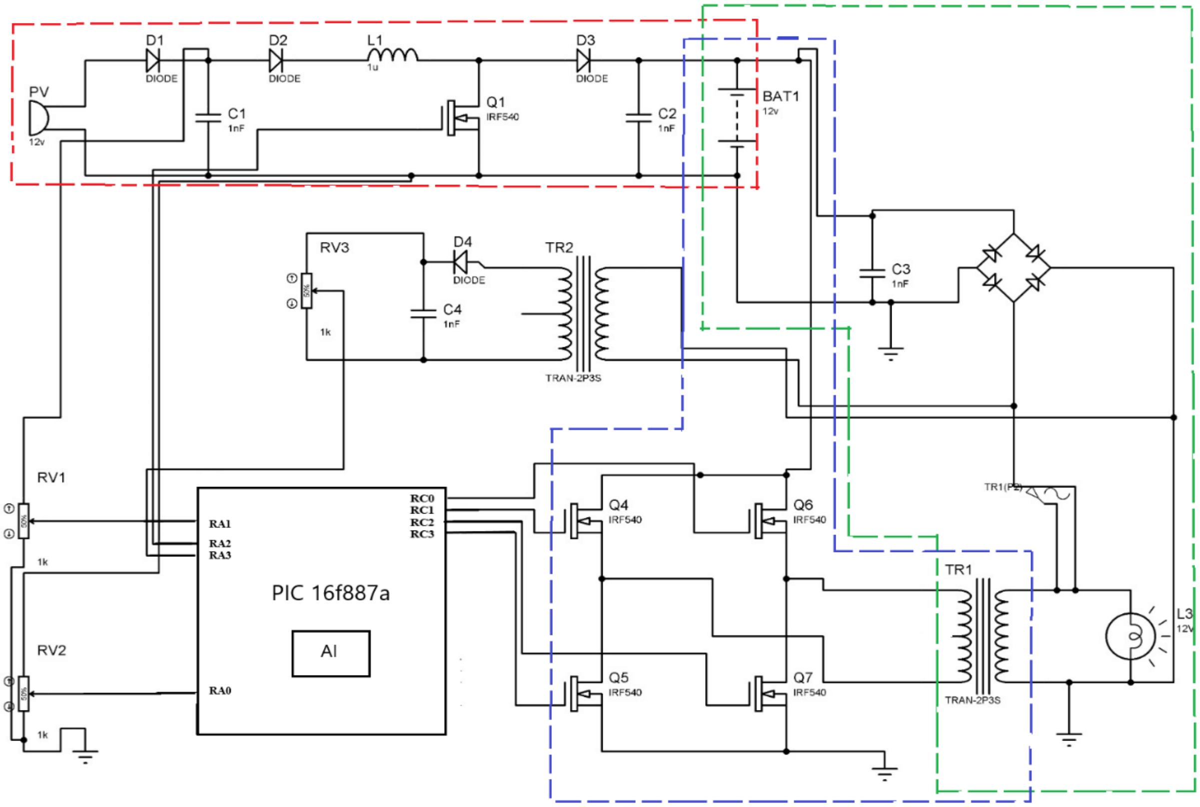

Figure 4.9 Circuit Diagram for Estimation Analysis of Renewable Energy Source Fed Battery Storage System For Vehicle To Grid Application Using Ai Techniques

The proposed renewable energy system collects and utilizes energy from renewable sources such as solar panels. Solar energy is converted into electrical energy through the use of MPPT (Maximum Power Point Tracking) and DC to DC converters. These technologies ensure that the system operates at its maximum efficiency and can adapt to varying weather conditions. The collected energy is then stored in batteries and ultra-capacitors to be utilized later. In addition to traditional batteries, this system also incorporates the use of ultra- capacitors, which are known for their high power density and rapid charge-discharge cycles. This allows for better management and utilization of energy generated from renewable sources, reducing wastage and providing a more reliable energy supply. The inclusion of advanced energy storage technologies is essential for the success of this renewable energy system. To optimize the performance of the system, artificial intelligence (AI) techniques such as neural networks and fuzzy logic are incorporated. These advanced control algorithms can predict energy demand and supply patterns, and make adjustments for optimal energy management. This ensures that the system operates at its maximum efficiency, reducing the cost of energy consumption. One of the major advantages of this renewable energy system is its ability to allow the flow of energy between the grid and electric vehicles. This enables vehicle-to-grid (V2G) applications, where electric vehicles can not only draw energy from the grid but also provide excess energy back to the grid when needed. This creates a more dynamic and efficient energy system and promotes the integration of electric vehicles into the grid. The proposed renewable energy system offers a cost-effective and reliable solution for managing and storing energy from renewable sources. By utilizing AI techniques and advanced energy storage technologies, the system can minimize energy wastage and optimize energy utilization, reducing the cost of energy consumption. Furthermore, the inclusion of renewable energy sources and V2G applications makes it a more sustainable and reliable option for energy supply. The AC power generated by the rectifier is then connected to the electrical grid through appropriate power electronics, typically an inverter.

4.4 MODE OF OPERATION

4.5.1 MODE 1 :

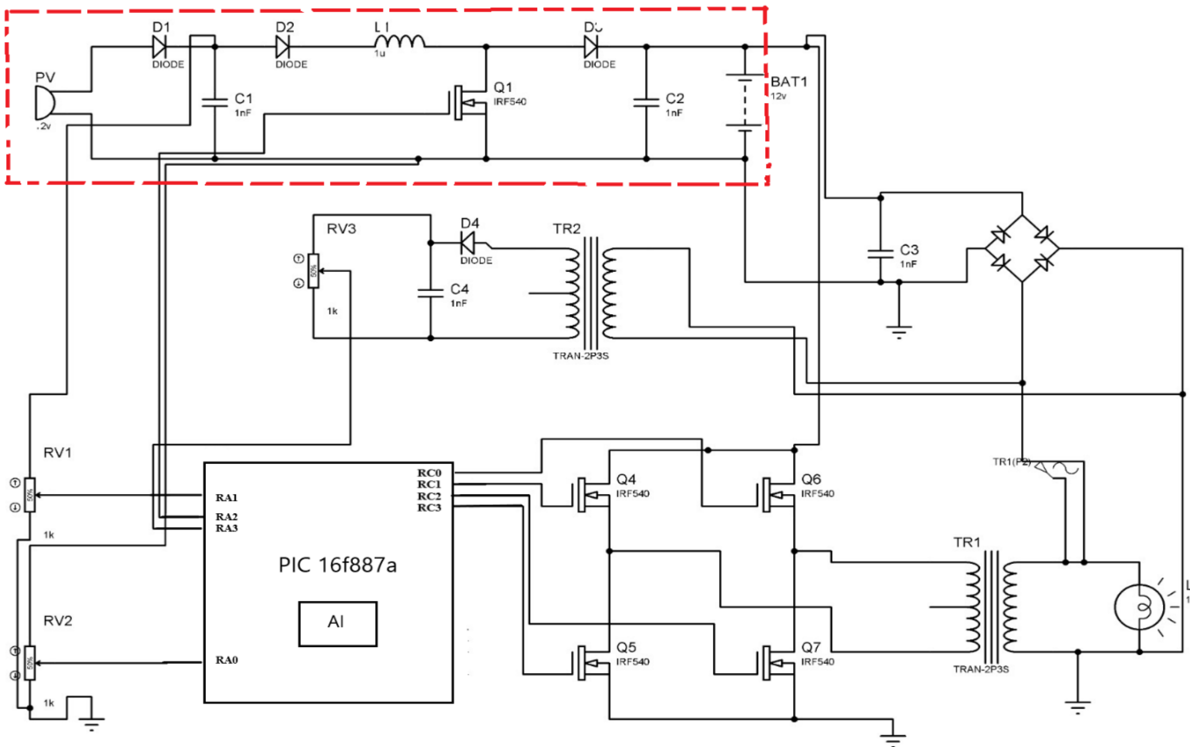

Figure 4.10 Mode of operation 1 of Proposed method of Estimation Analysis of Renewable Energy Source Fed Battery Storage System For Vehicle To Grid Application Using AI Techniques

Figure 4.10 say about the input source in this proposed diagram is Estimation Analysis of renewable energy source that uses solar photovoltaic (PV) technology. It has a 12V, 10KW panel with irradiation, and the power supply flows to a diode to prevent system short circuits. The capacitor is connected to the PV line to allow power to flow to an inductance, which stores energy in a DC battery.

4.5.2 MODE 2:

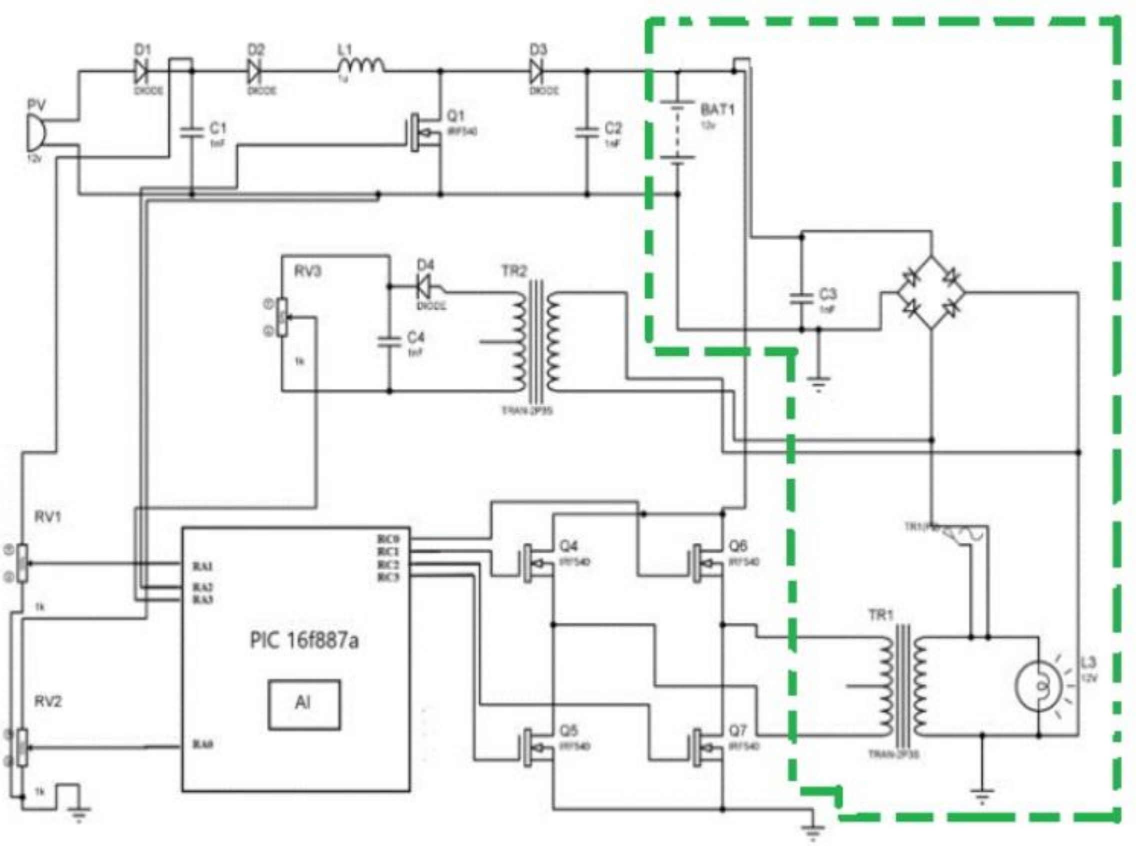

Figure 4.11 Mode of Operation 2 of proposed method of Estimation Analysis of Renewable Energy Source Fed Battery Storage System For Vehicle To Grid Application Using AI Techniques

Figure 4.11 say about the proposed diagram, we derive input from the Electric Vehicle (EV) Battery as a DC supply converter which is then transformed into AC by the Inverter of V2G application. The Inverter effectively converts DC to AC and feeds back to the grid based on the Vehicle to Grid (V2G) model. Inverter V2G technology allows Electric Vehicle (EV) to not only charge from the grid but also discharge excess energy back into the grid when needed. This is useful for grid stabilization, especially during peak demand periods or in response to fluctuations in renewable energy generation.

4.5.3 MODE 3:

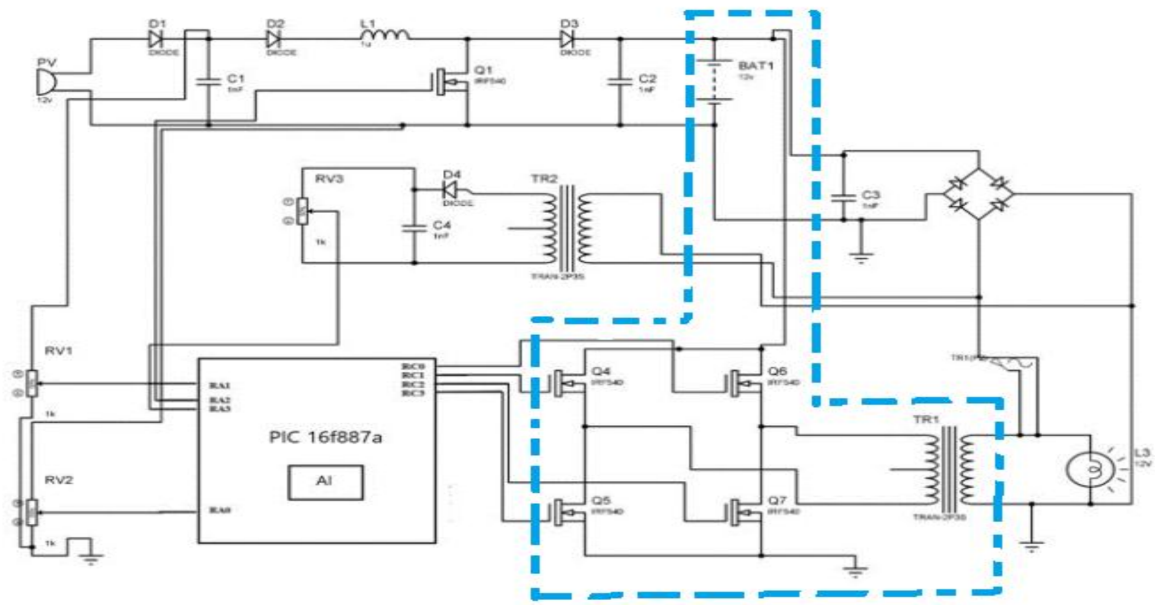

Figure 4.12 Mode of Operation 3 of Proposed method of Estimation Analysis of Renewable Energy Source

Figure 4.12 say about the proposed emergency situation diagram, we have incorporated grid power as a backup procedure to provide continuous power supply to the load areas during peak demand. The battery is charged using the continuous power supply from the grid. As solar energy cannot be procured at all times due to varying weather conditions, we rely on grid power for charging the battery as a backup storage option. Additionally, in some cases, the stored battery power can act as back production from the Vehicle to Grid (V2G) model. The utilization of Maximum Power Point Tracking (MPPT) results in a heightened power factor for solar energy across varying levels of irradiance. This technology enables an increase or decrease in supply from the PV as needed.Application Using AI Techniques

4.5 Summary

Renewable Energy Sources: of Solar panels and wind turbines are employed to capture energy from the environment. These sources are highly sustainable and eco-friendly. Battery Storage: A high-capacity battery serves as the energy reservoir, storing surplus energy for times when the renewable sources are not producing electricity, thus ensuring a constant power supply. Vehicle-to-Grid (V2G) has EVs can act as mobile energy storage units, providing electricity back to the grid when needed. This concept not only makes EVs more versatile but also contributes to grid stability during peak demand periods.

CHAPTER 5

RESULT AND DESCRIPTION

5.1 INTRODUCTION

The proposed system that is going to be described in this phase is done using the Mat Lab Simulation model. In order to get the desired output, the simulation circuit has beendesigned in Mat Lab software by using the respective components that is present in the MatLab stimulant. This simulation circuit will be described in detail below.

5.2 SIMULINK DESCRIPTION

A block diagram environment for multi domain simulation and Model-Based Design. It supports system-level design, simulation, automatic code generation, and continuous test and verification of embedded systems. Simulink provides a graphical editor, customization block libraries, and solvers for modeling and simulating dynamic systems. It is integrated with MATLAB, enabling you to incorporate MATLAB algorithms into models and export simulation results to MATLAB for further analysis. To the model algorithms and physical systems using block diagrams. You can model linear and nonlinear systems, factoring in real-world phenomena such as friction, gear slippage, and hard stops. On the can interactively simulate your system and view the results on scopes and graphical displays. For simulation of continuous, discrete, and mixed-signal systems, youcan choose from a range of fixed-step and variable-step solvers. Solvers are integration algorithms that compute system dynamics over time. The component-based modeling and modular design. Implement sensors and data acquisition systems to gather real-time data on energy generation from RES, grid demand, battery status, and EV charging/discharging patterns. This data forms the basis for AI algorithms to optimize system operation. Develop ML algorithms to predict energy generation from RES based on historical data, weather forecasts, and other relevant parameters. ML models can also forecast EV charging/discharging patterns and grid demand fluctuations. Implement RL algorithms to optimize energy management strategies for the V2G system. RL agents learn to make decisions on when to charge or discharge the battery, considering factors such as energy prices, grid stability, and user preferences. Utilize neural network models for load forecasting, energy price prediction, and optimization of V2G operations. Deep learning techniques can enhance the accuracy of predictions and decision-making processes. Use AI algorithms to determine the optimal schedule for EV charging/discharging and battery operation to minimize costs, maximize RES utilization, and ensure grid stability. Employ energy storage capabilities to smooth out peaks in energy demand and fill valleys in RES generation, thus reducing strain on the grid and enhancing overall system efficiency. Implement control mechanisms to manage bidirectional power flow between EVs, the grid, and the battery storage system. Prioritize charging/discharging based on grid conditions, energy prices, and user preferences while ensuring EV battery health. In SIMULINK, a block is a fundamental building element used to create dynamic systems and models for simulation and analysis. Each block represents a mathematical operation, a physical component, a logical operation, or any other function necessary to model a system's behavior. Each block is represented by an icon that visually represents its function or operation. The icon typically gives a clue about the block's purpose at a glance, making it easier for users to identify and understand its role in the model. Blocks can have various parameters that define their behavior or characteristics. These parameters can be set by the user to customize the block's functionality according to the requirements of the system being modeled. Parameters might include things like gain, frequency, time delay, etc., depending on the type of block.

5.3 SIMULATION DIAGRAM FOR EXISTING METHOD

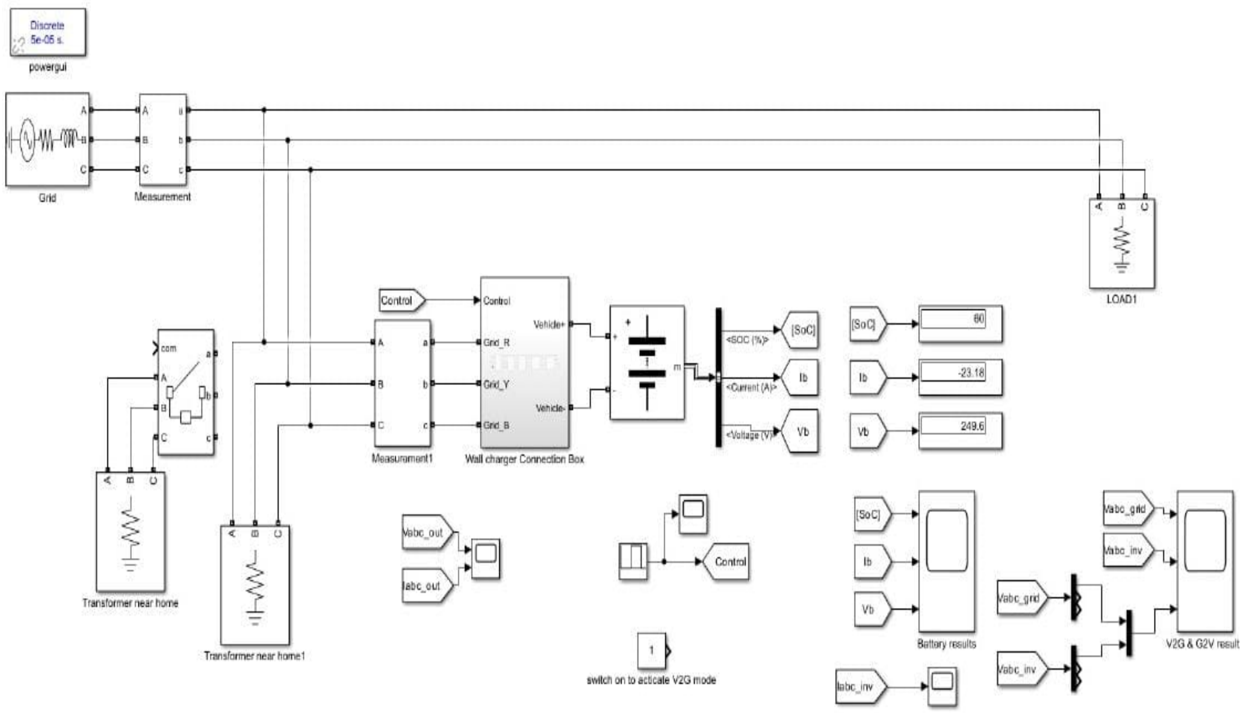

Figure 5.1 Simulation of Existing Method.

In this Existing diagram, we obtain the energy source from the grid to charge the Electric Vehicle (EV) battery and invert the supply back to the grid. This process is known as Vehicle-to-Grid (V2G), which involves transferring power stored in EV batteries by utilizing an inverter to pay back to the grid. The transformer connects the grid's power supply to the load, which then passes it on to the Converter. This device converts the AC supply into a DC supply that can be stored in the Electric Vehicle Battery. The battery has a capacity of 12V and feeds into an inverter that uses a rectifier to convert DC back into AC for feedback to the grid. This process is known as Vehicle-to-Grid (V2G). The PIC Micro Controller controls and maintains application, with an input supply of 5V.

5.4 SIMULATION DIAGRAM FOR PROPOSED METHOD

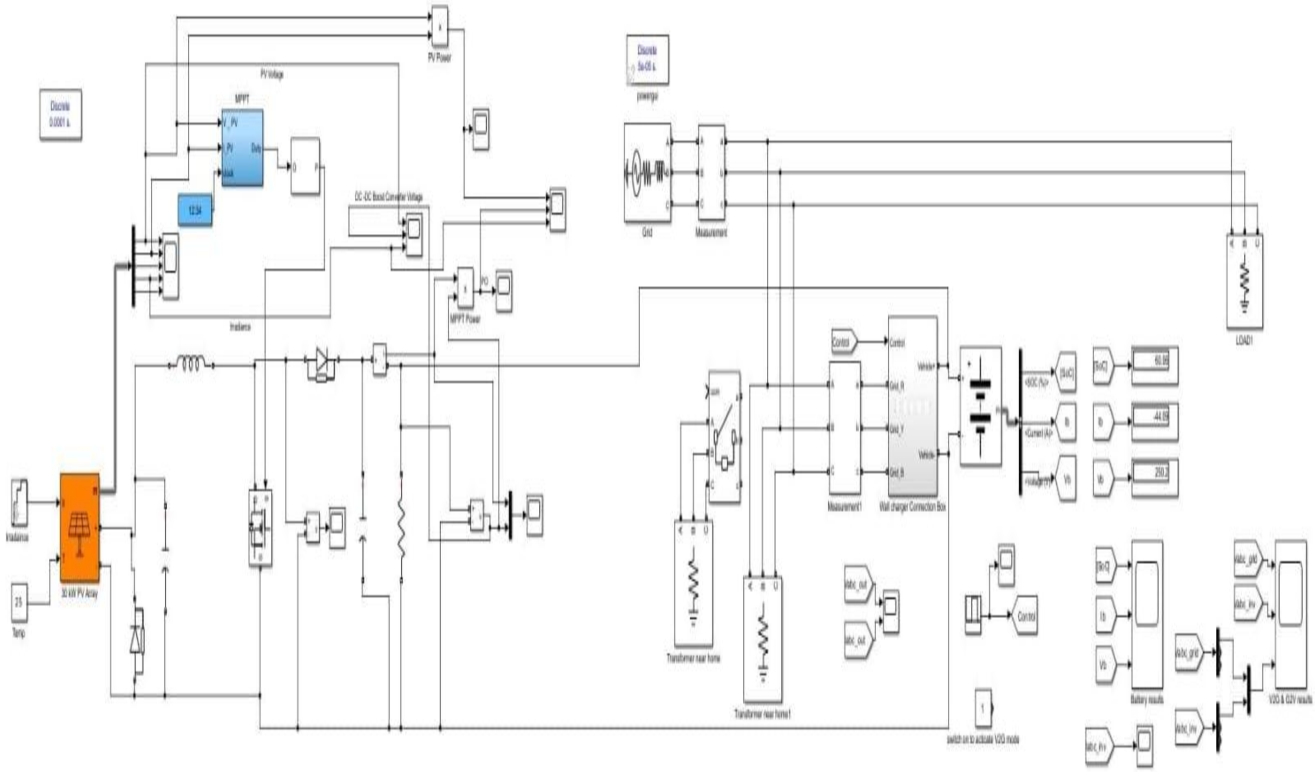

Figure 5.2 Simulation of Proposed Method

The proposed renewable energy system collects and utilizes energy from renewable sources such as solar panels. Solar energy is converted into electrical energy through the use of MPPT (Maximum Power Point Tracking) and DC to DC converters. These technologies ensure that the system operates at its maximum efficiency and can adapt to varying weather conditions. The collected energy is then stored in batteries and ultra-capacitors to be utilized later. In addition to traditional batteries, this system also incorporates the use of ultra- capacitors, which are known for their high power density and rapid charge-discharge cycles. This allows for better management and utilization of energy generated from renewable sources, reducing wastage and providing a more reliable energy supply. The inclusion of advanced energy storage technologies is essential for the success of this renewable energy system. To optimize the performance of the system, artificial intelligence (AI) techniques such as neural networks and fuzzy logic are incorporated.

These advanced control algorithms can predict energy demand and supply patterns, and make adjustments for optimal energy management. This ensures that the system operates at its maximum efficiency, reducing the cost of energy consumption. One of the major advantages of this renewable energy system is its ability to allow the flow of energy between the grid and electric vehicles. This enables vehicle-to-grid (V2G) applications, where electric vehicles can not only draw energy from the grid but also provide excess energy back to the grid when needed. This creates a more dynamic and efficient energy system and promotes the integration of electric vehicles into the grid. The proposed renewable energy system offers a cost-effective and reliable solution for managing and storing energy from renewable sources. By utilizing AI techniques and advanced energy storage technologies, the system can minimize energy wastage and optimize energy utilization, reducing the cost of energy consumption. Furthermore, the inclusion of renewable energy sources and V2G applications makes it a more sustainable and reliable option for energy supply. The AC power generated by the rectifier is then connected to the electrical grid through appropriate power electronics, typically an inverter.

5.5 EXISTING OUTPUT

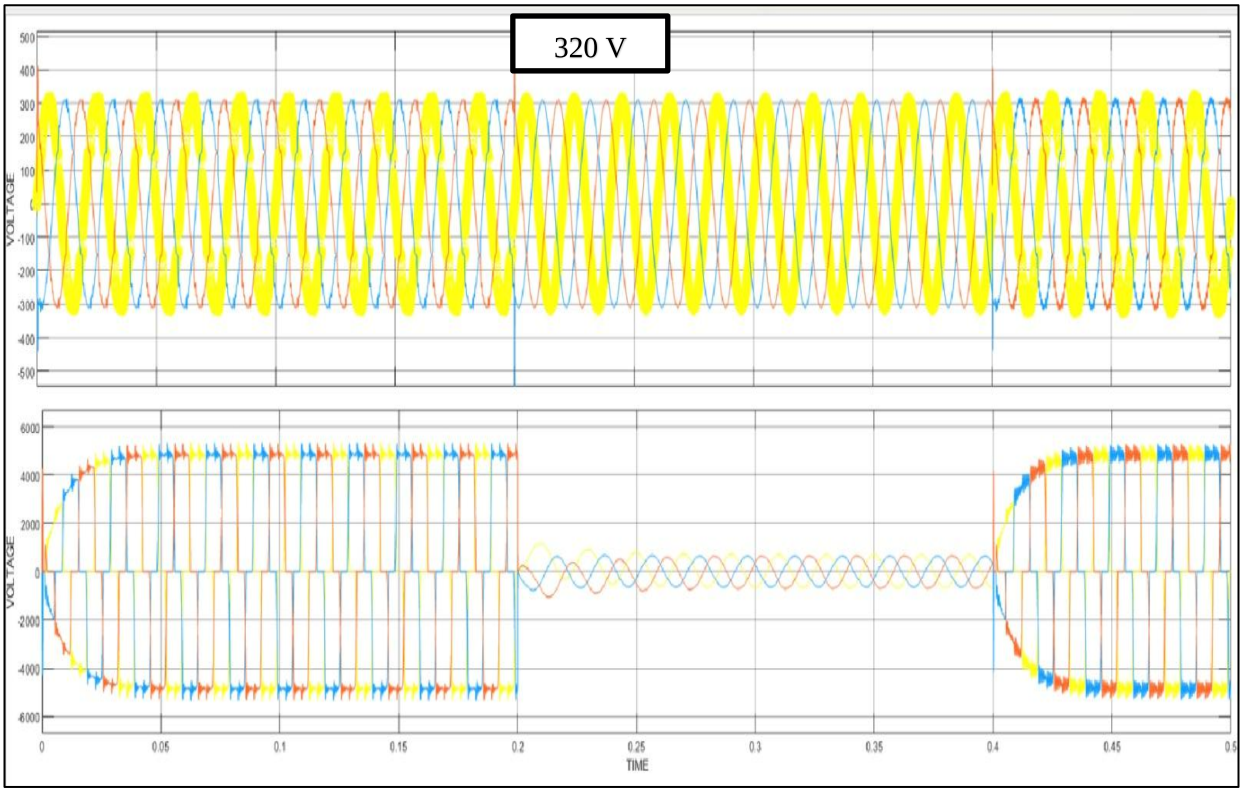

Figure 5.3 Output Wave Form of Voltage and Current during supply to the Grid

Figure 5.3 describes about the Voltage and Current output of the current Vehicle-to-Grid (V2G) approach is determined by the input voltage and current received from the wall charger connection, which charges the battery to a State Of Charge. The output of the voltage of the battery -23.18 and a current of 236.6 amperes. The Control output will be linked to the wall charger connection Box in order to deliver power to the battery as shown in Figure 5.4

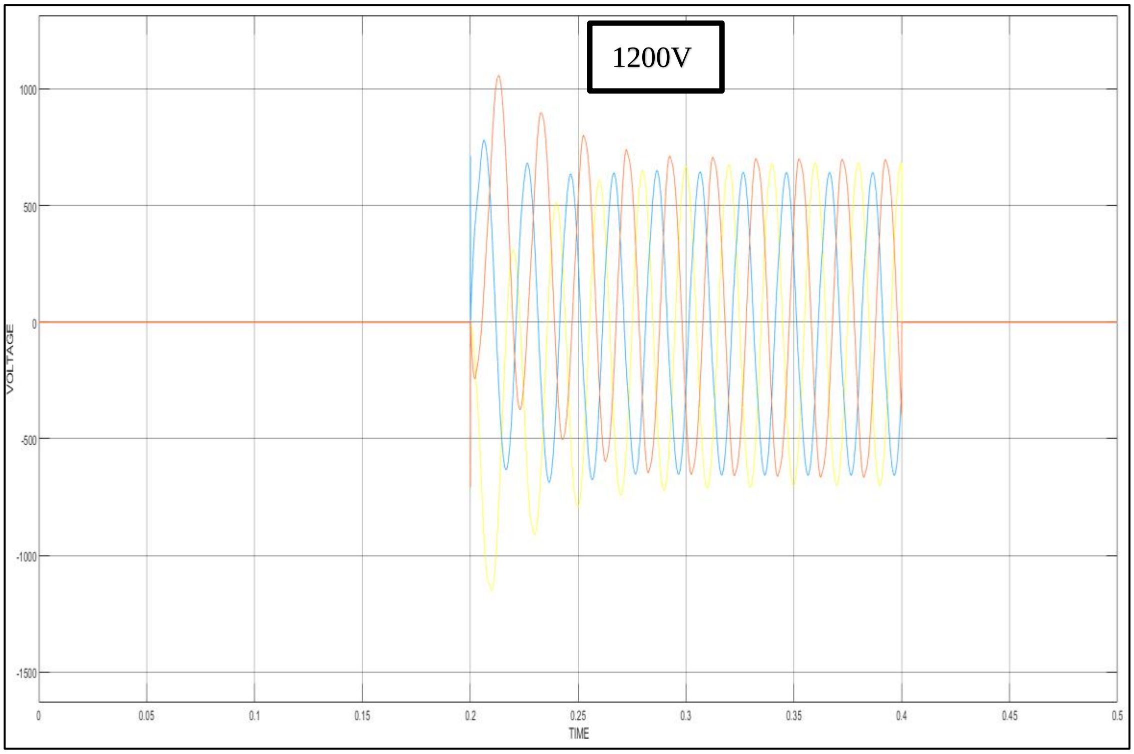

Figure 5.4 Output wave form of control during supply to the battery

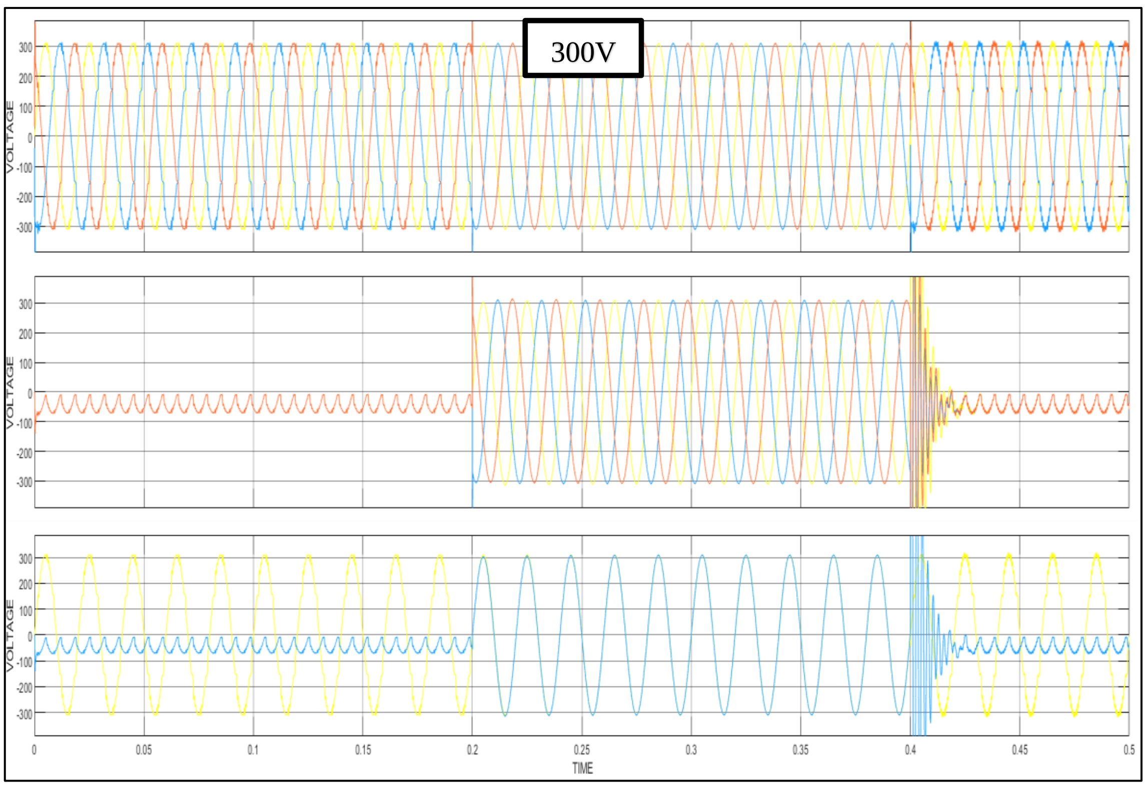

Figure 5.5 Output wave form of V2G and G2V

Figure 5.5 will describes about the Vehicle to Grid and Grid to Vehicle Output of an the Existing Method based on the input and output supply to charge the battery. we derive input from the Electric Vehicle (EV) Battery as a DC supply converter which is then transformed into AC by the Inverter of V2G application. The Inverter effectively converts DC to AC and feeds back to the grid based on the Vehicle to Grid model. The Grid to Vehicle application receives input supply from the grid in order to charge the battery.

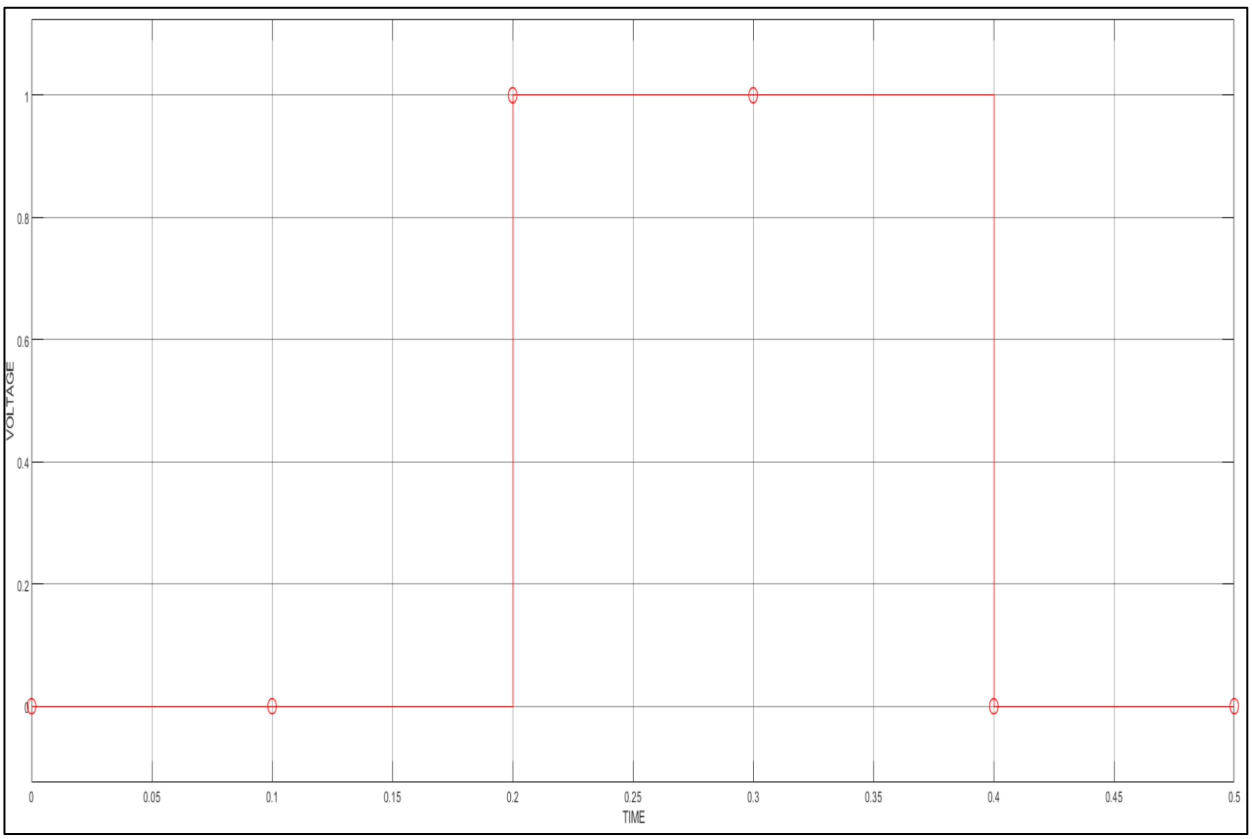

Figure 5.6 Output wave form of Inverter

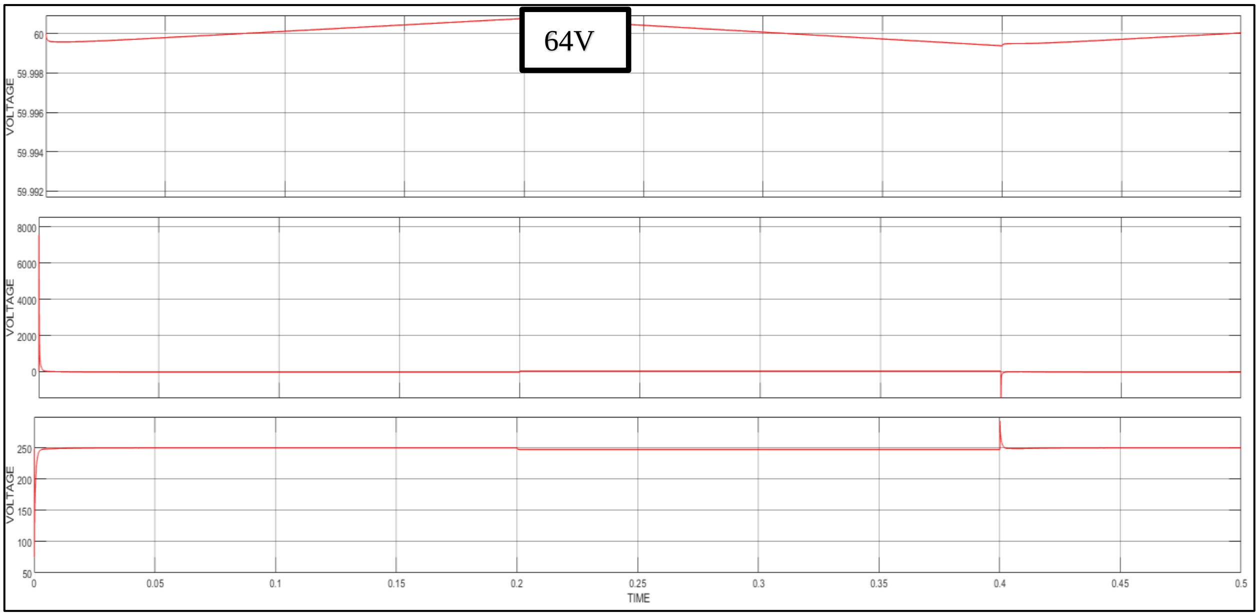

Figure 5.7 Output wave form of battery performance

5.6 PROPOSED OUTPUT

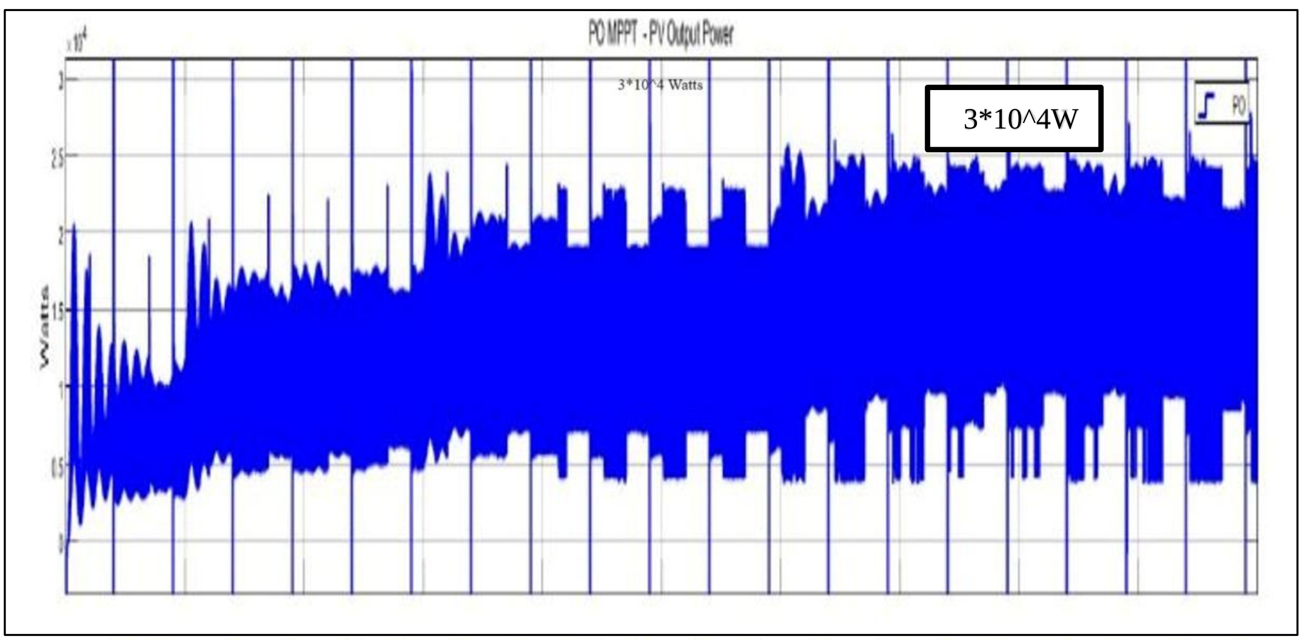

Figure 5.8 Output waveform of power output of maximum power point tracking and photo voltaic

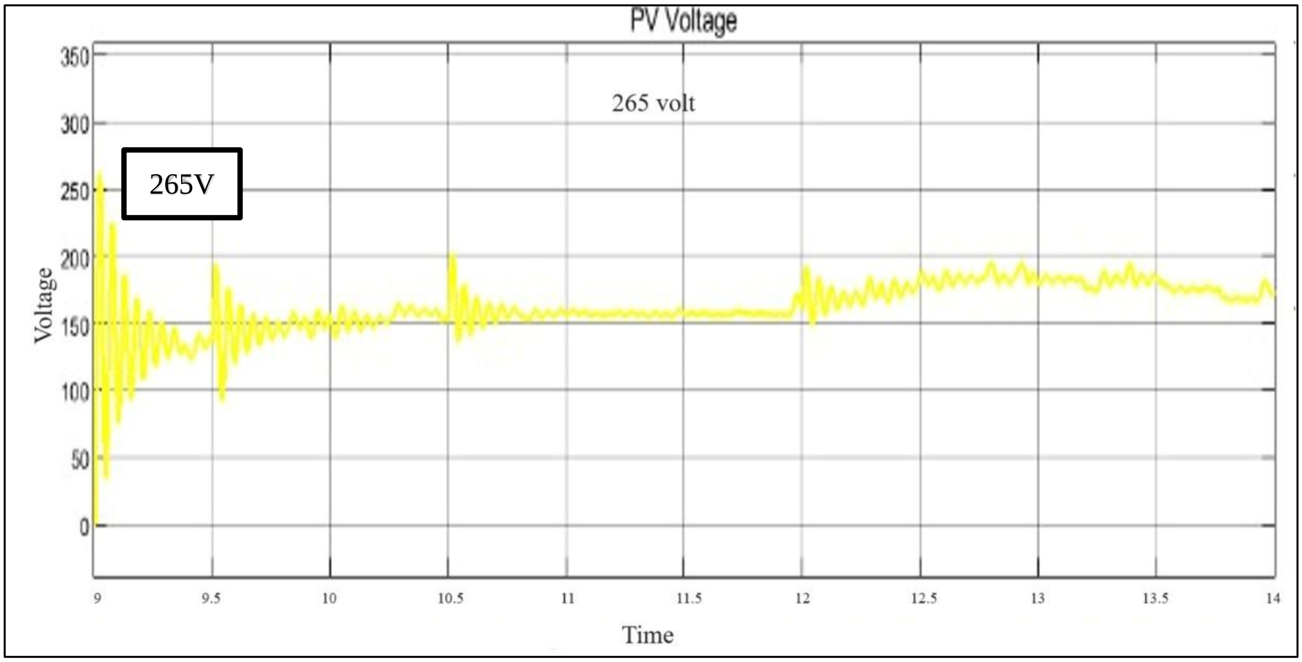

Figure5.9 Output voltage of photo voltaic

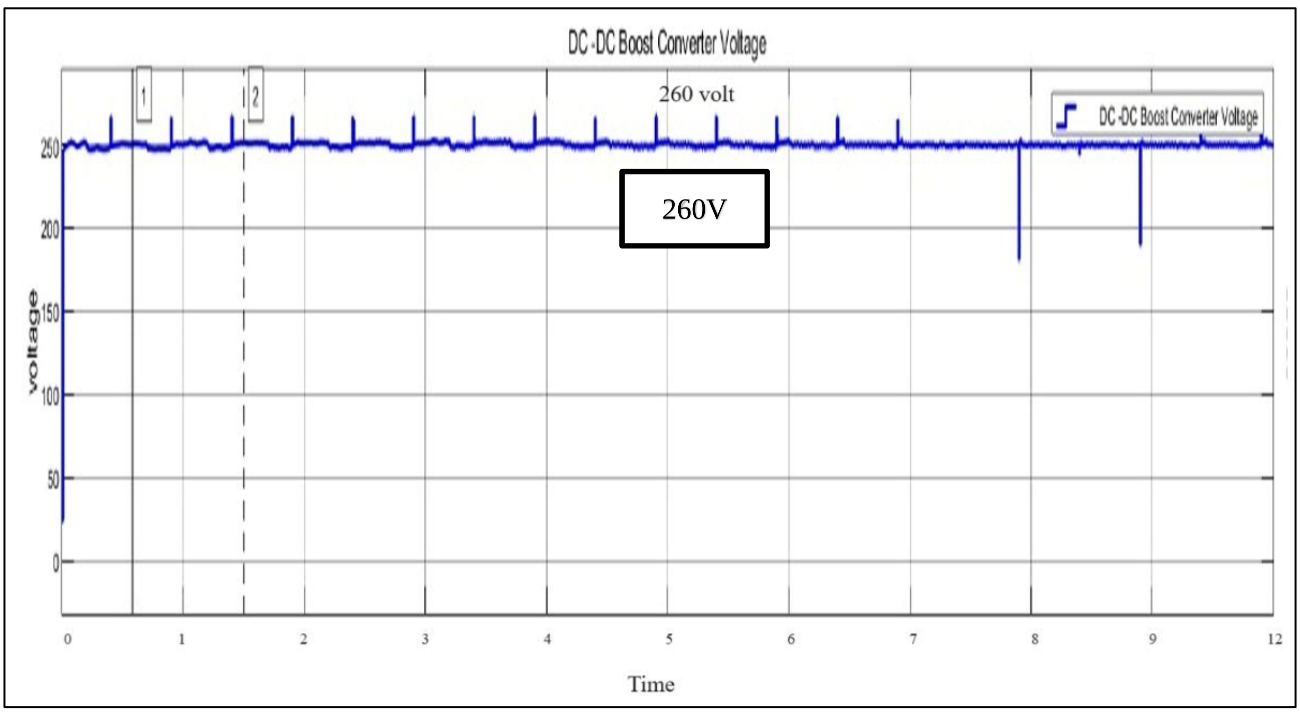

Figure 5.10 Output voltage wave form of dc-dc boost converter

Figure 5.8 will describe about the power generated through Maximum Power Point Tracking and Photo Voltaic output in the proposed method is dependent on the solar panel's output, which charges the battery while maintaining a consistent power supply according to irradiance levels. It also regulates input supply from the solar panel by boosting or reducing it as needed as shown in the Figure 5.9.

The Photo voltaic Voltage output of the proposed system based on the irradiance level can extract the Maximum solar panel power to fully charge the battery for the grid's ongoing supply. The voltage output of the DC-DC Boost Converter as shown in the Figure 5.10

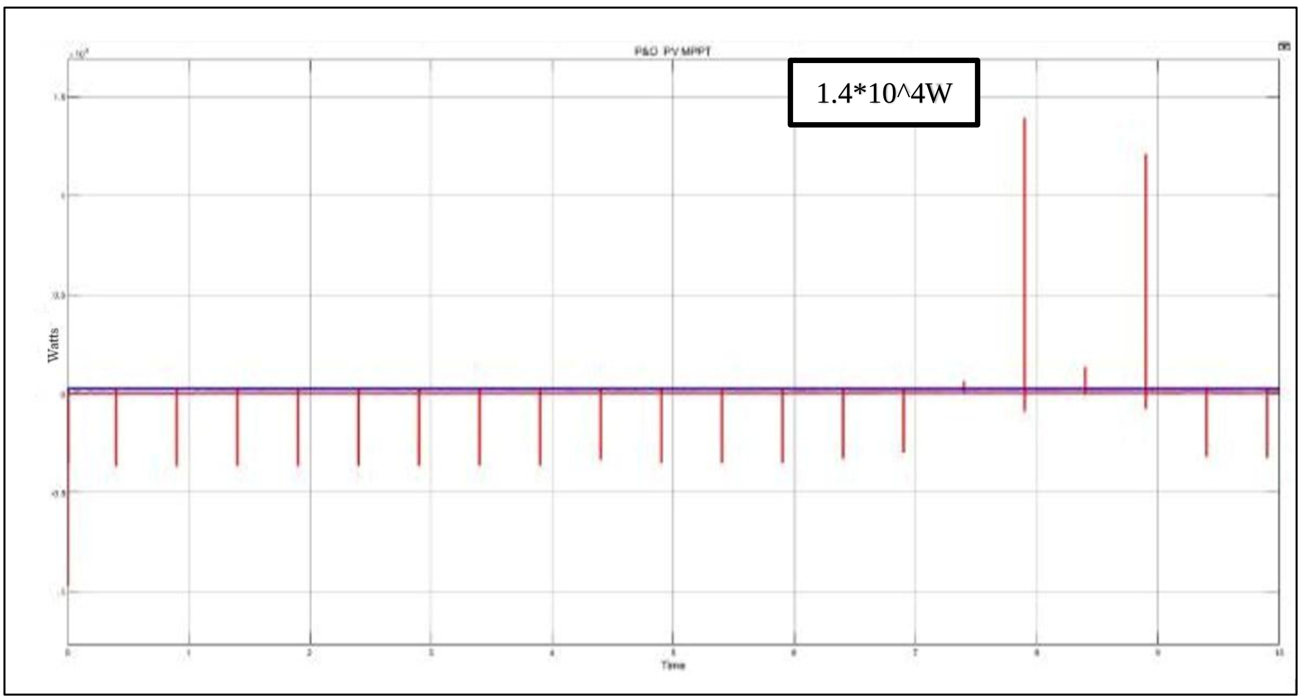

Figure 5.11 Output wave form of the power and photo voltaic during maximum power point tracking

Figure 5.11 will describe about the output Voltage and photo voltaic during MPPT will be linked to the wall charger connection Box in order to deliver power to the battery The Voltage and Current output of the current Vehicle-to-Grid (V2G) approach is determined by the input voltage and current received from the wall charger connection, which charges the battery to a State Of Charge. The output voltage of the battery -23.18 and a current of 236.6 amperes. The output Voltage and photo voltaic during MPPT will be linked to the wall charger connection Box in order to deliver power to the battery as shown in the Figure 5.12.

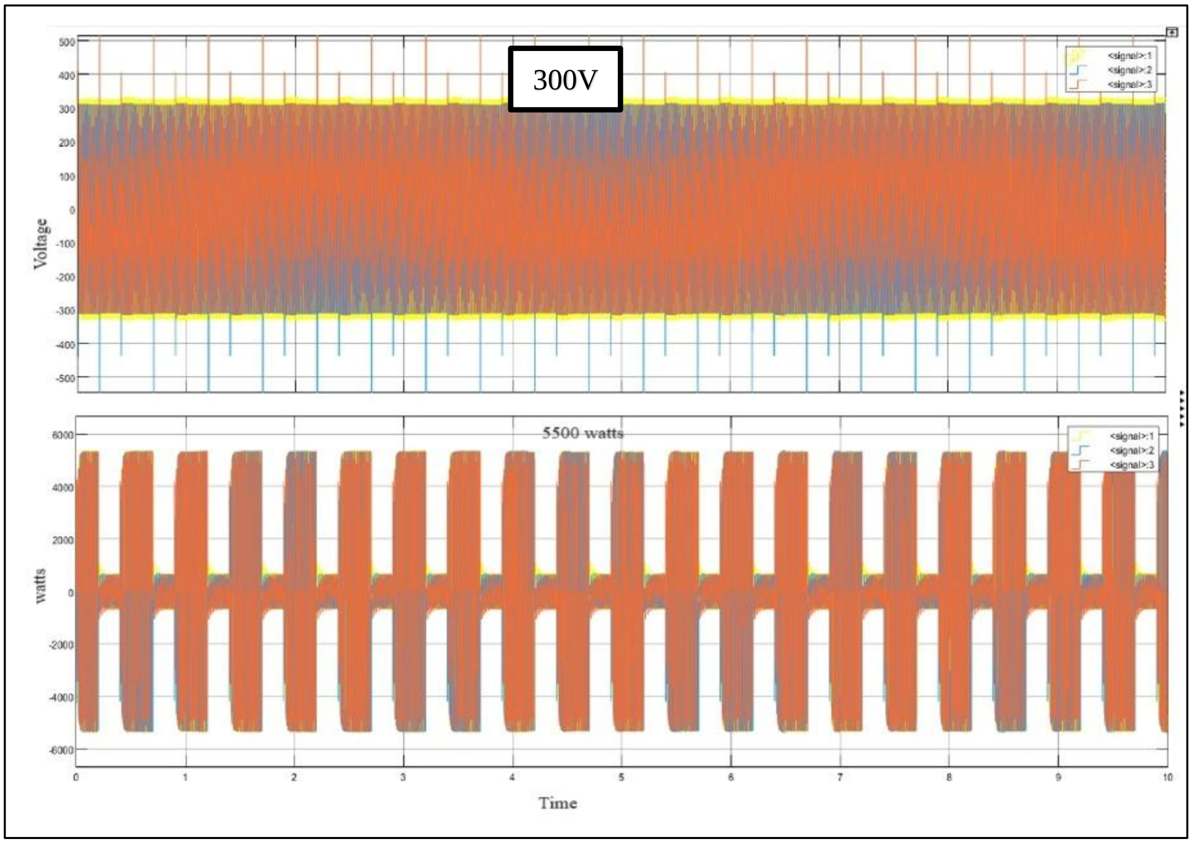

Figure 5.12 Power output of photo voltaic during maximum power point tracking

The proposed system was to use an inverter to change the direct current (DC) stored in a battery to alternating current (AC). After that, the grid will get this AC electricity again. The inverter has responsible for this conversion process and allows the system to supply electricity to the grid as shown in the Figure 5.12.

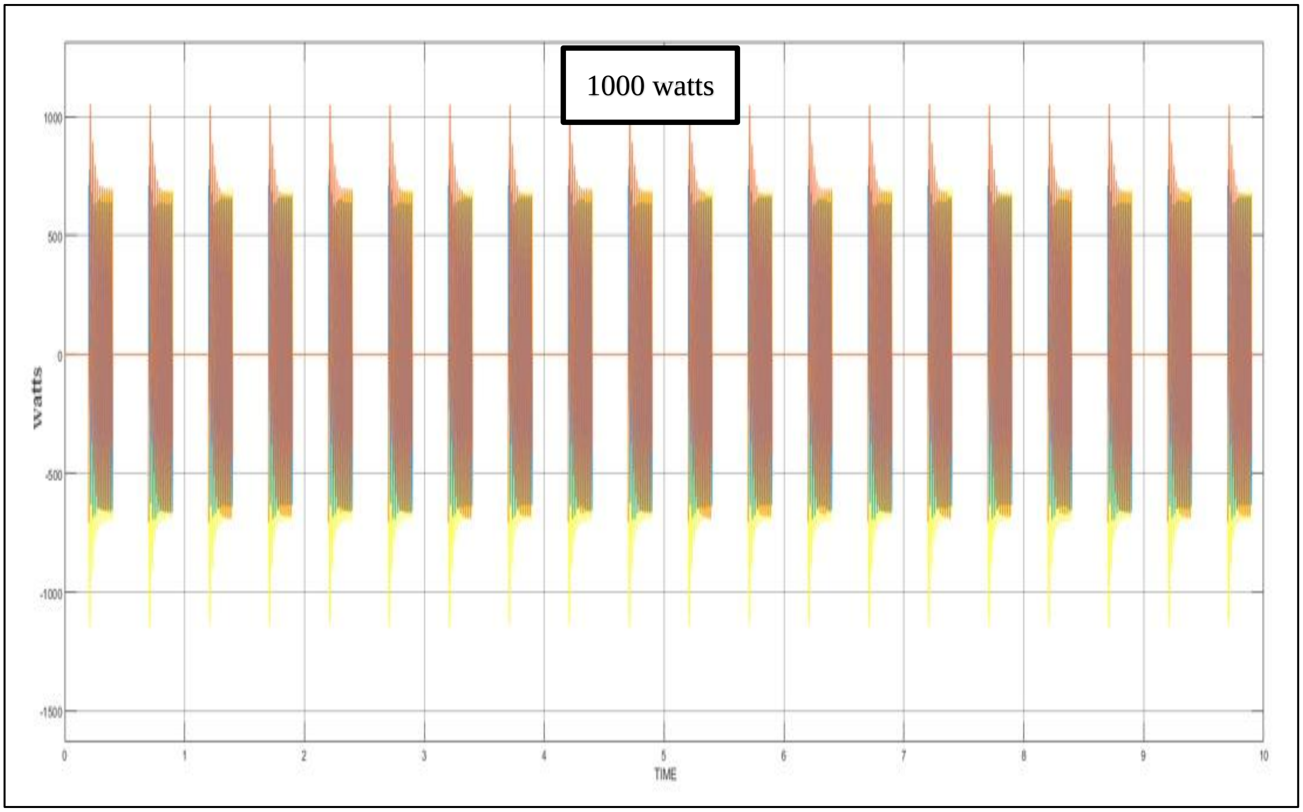

Figure 5.13 Output wave form of inverter during vehicle to grid

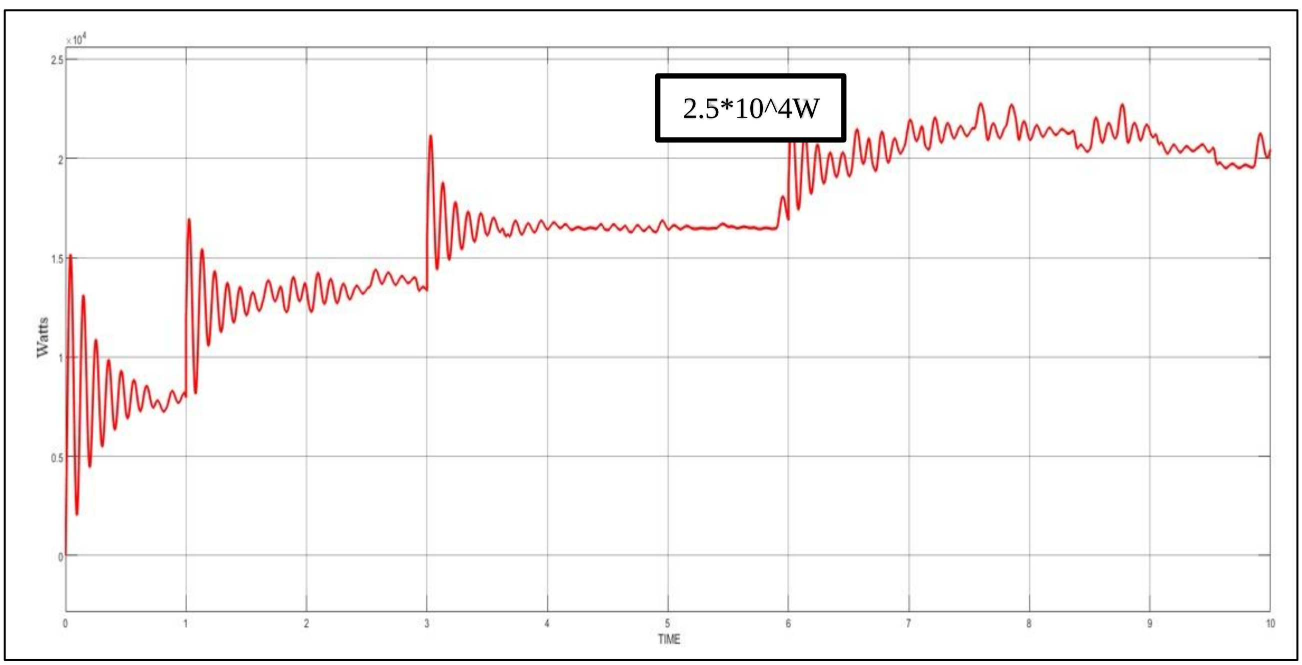

Figure 5.14 Output wave form of PV Voltage

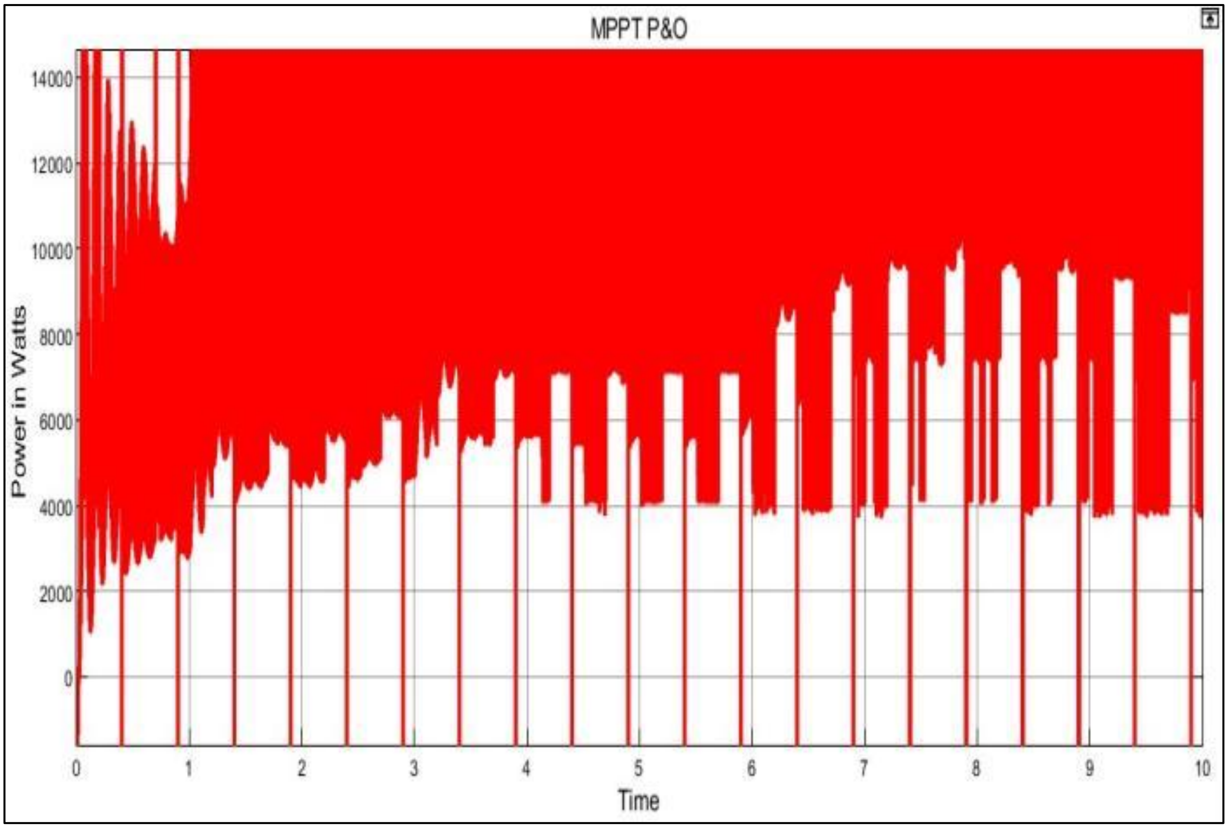

Figure 5.15 Output wave form of maximum power point tracking

Figure 5.15 describes about the output waveform of PV Voltage and input and output voltage from the Solar to the battery of the Electric Vehicle and the output wave form of the Maximum Power Point Tracking of the Solar energy to the grid and feedback the supply to the battery Shown in FIGURE 6.The solar irradiation based on the different output wave form from the solar panel while the battery figure 5.16.

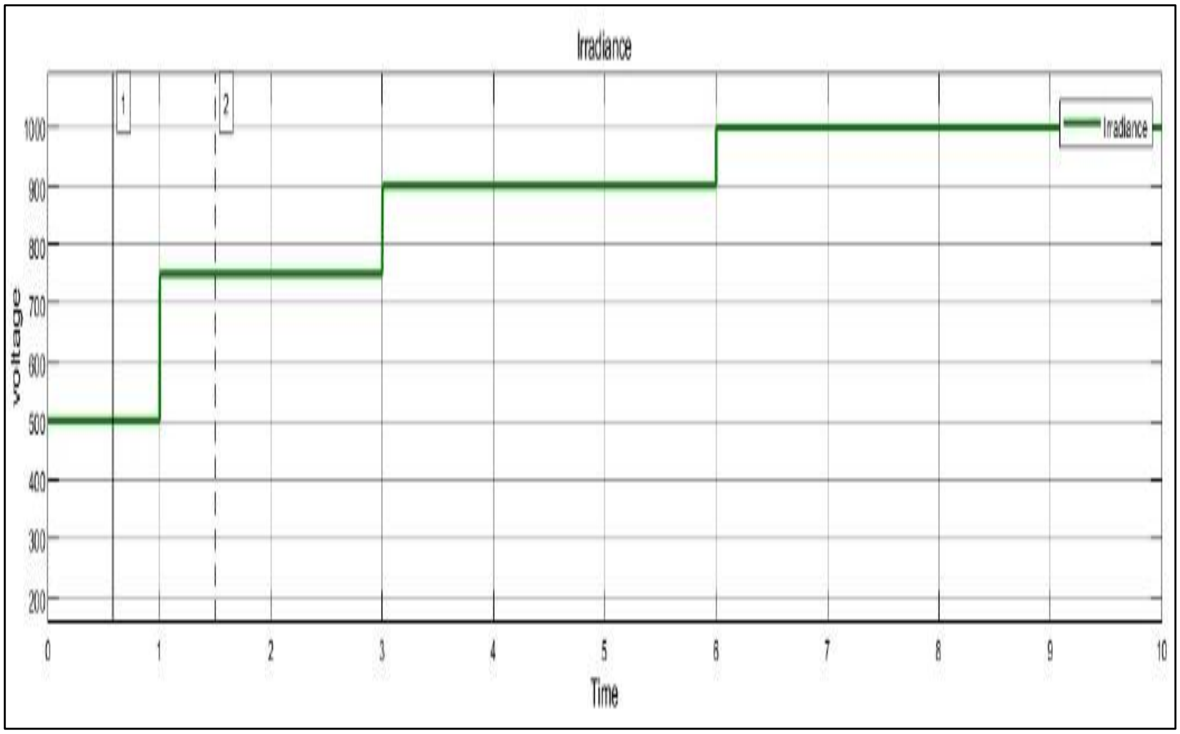

Figure 5.16 Different Output wave form of irradiation of PV panel during charging

5.7 COMPARISON TABLE

S.NO	Parameters	Existed System	Proposed System
1	Battery	12V	12V
2	Output Voltage	230V	230V
3	PIC 16f887A	5V	5V
4	Diode	1MAH	1MAH
5	Capacitor	1000uf	1000uf, 25000uf
6	Resistor	1k ohm	1k ohm,10k ohm
7	Efficiency	50%	95%

5.8 SPECIFICATION OF HARDWARE COMPENENTS

S.NO.	Components	Specification
1	PIC16F887A	To enable simple programming and interfacing in embedded system design.
2	INVERTER	It converts the DC power supply into AC power supply
3	STEP-DOWN TRANSFORMER	They are designed to reduce the voltage level of an AC power supply.
4	DC-DC CONVERTER	To convert and stabilize the voltage
5	AC-DC CONVERTER	To store the electric energy converts the AC Supply to DC Supply.
6	LITHIUM ION BATTERY	It will store only the DC power supply
7	PHOTO VOLTAIC	It is used to reduce the carbon footprint
8	ULTRA CAPACITOR	They are used in battery application that offers high power density and discharging

5.9 BAR CHART OF RENEWABLE ENERGY SOURCE

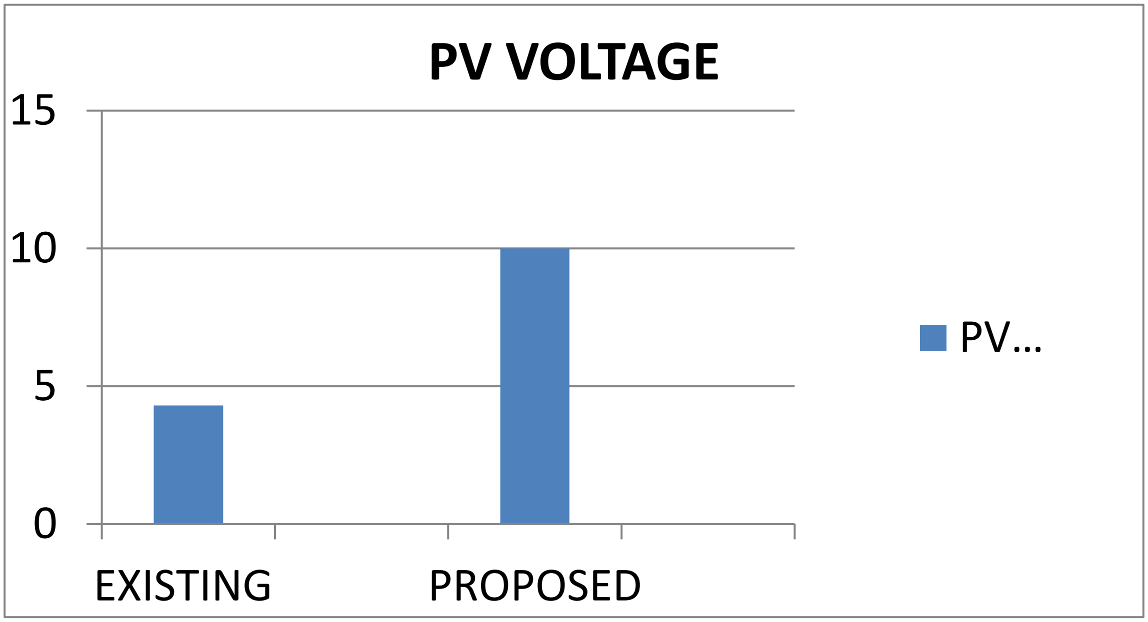

Figure 5.17 Comparison of Existing and Proposed PV Voltage of RES

A comparison of the renewable energy source's actual and intended solar voltage is shown in Figure 5.17; the current output is 4.3V, while the proposed output is 10V.

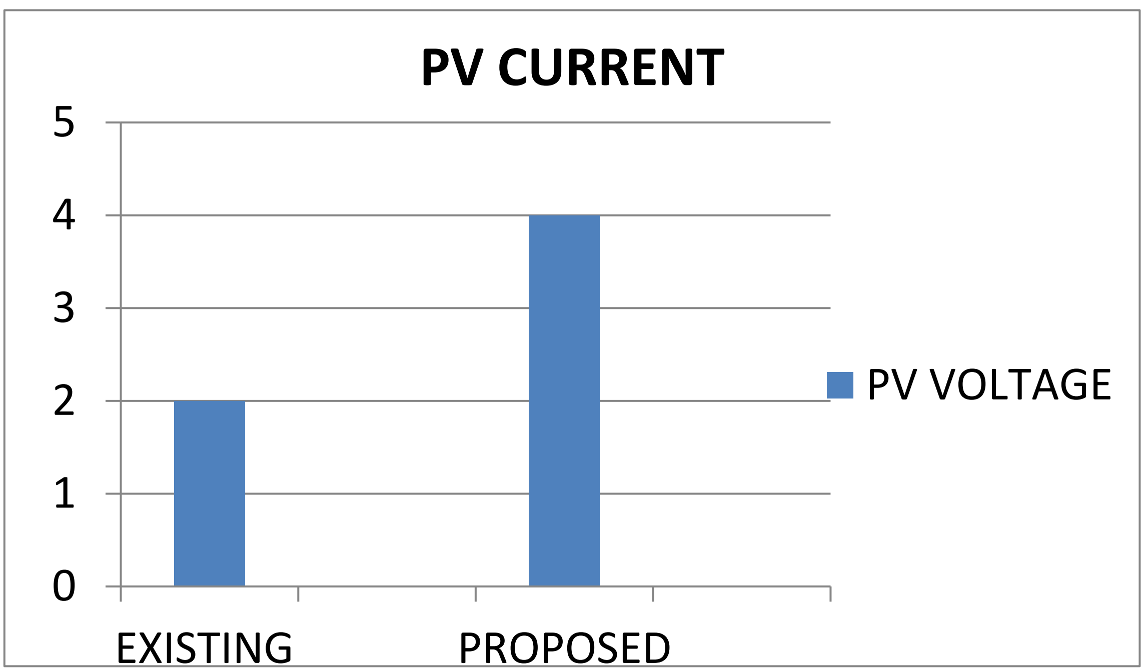

Figure 5.18 Comparison of Existing and proposed PV current of RES

Figure 5.18 describes about the comparison of the renewable energy source's actual and intended solar Current; the current output is 2A, while the proposed output is 4V.

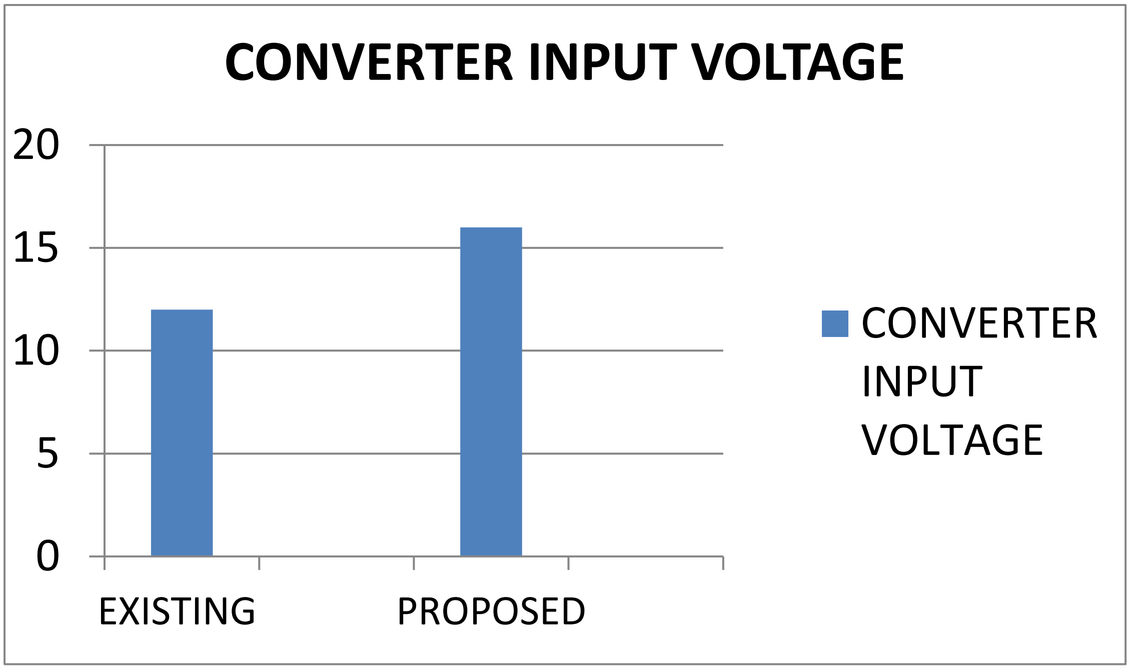

Figure 5.19 Comparison of Existing and proposed Converter Input voltage of RES

Figure 5.19 explains about the Converter Input Voltage in the existing and proposed system the converter input voltage in existing will be 12V and the proposed will be 16V. Figure 5.20 demonstrates the Converter Input Voltage in the existing and proposed systems. The converter input Current in the present system is 12A, whereas the proposed Current is 16A.

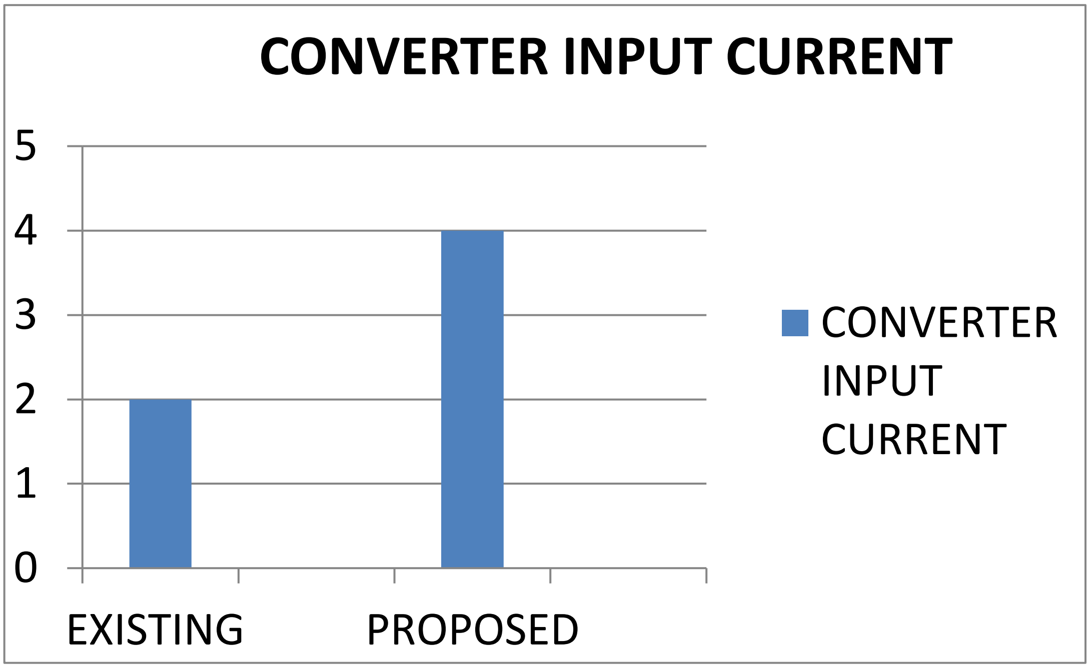

Figure 5.20 Comparison of Existing and Proposed method of converter Input Current of RES

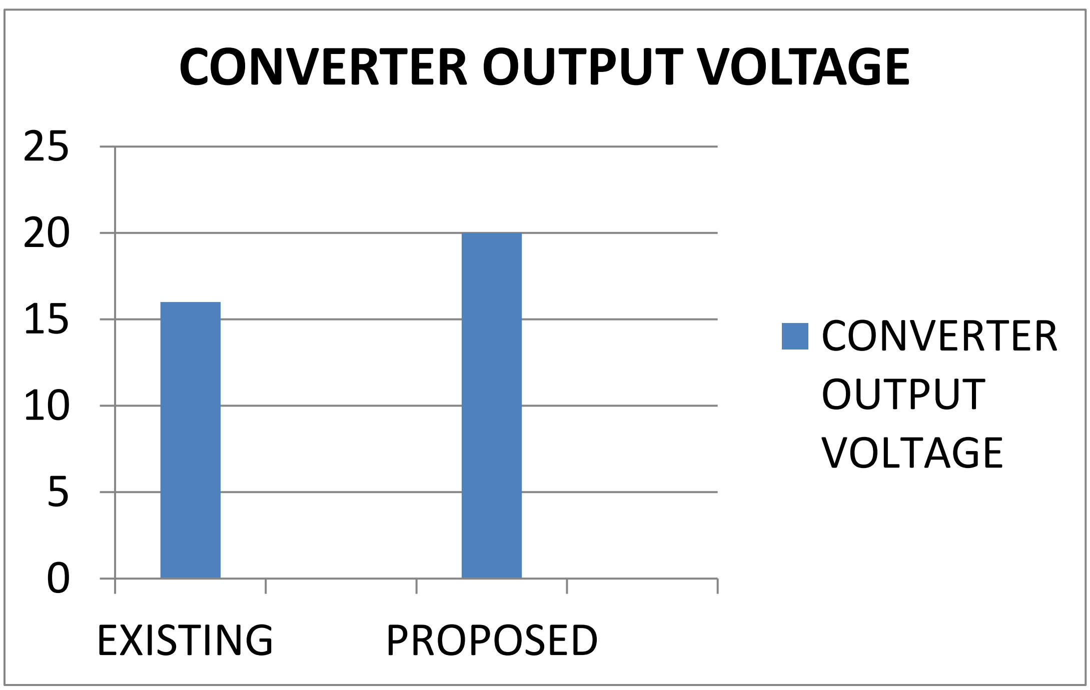

Figure 5.21 The Existing and Proposed method of Converter Output of RES

Figure 5.21 demonstrates the Converter Output Voltage in the existing and proposed systems. The converter output voltage in the present system is 20V, whereas the proposed voltage is 16V.

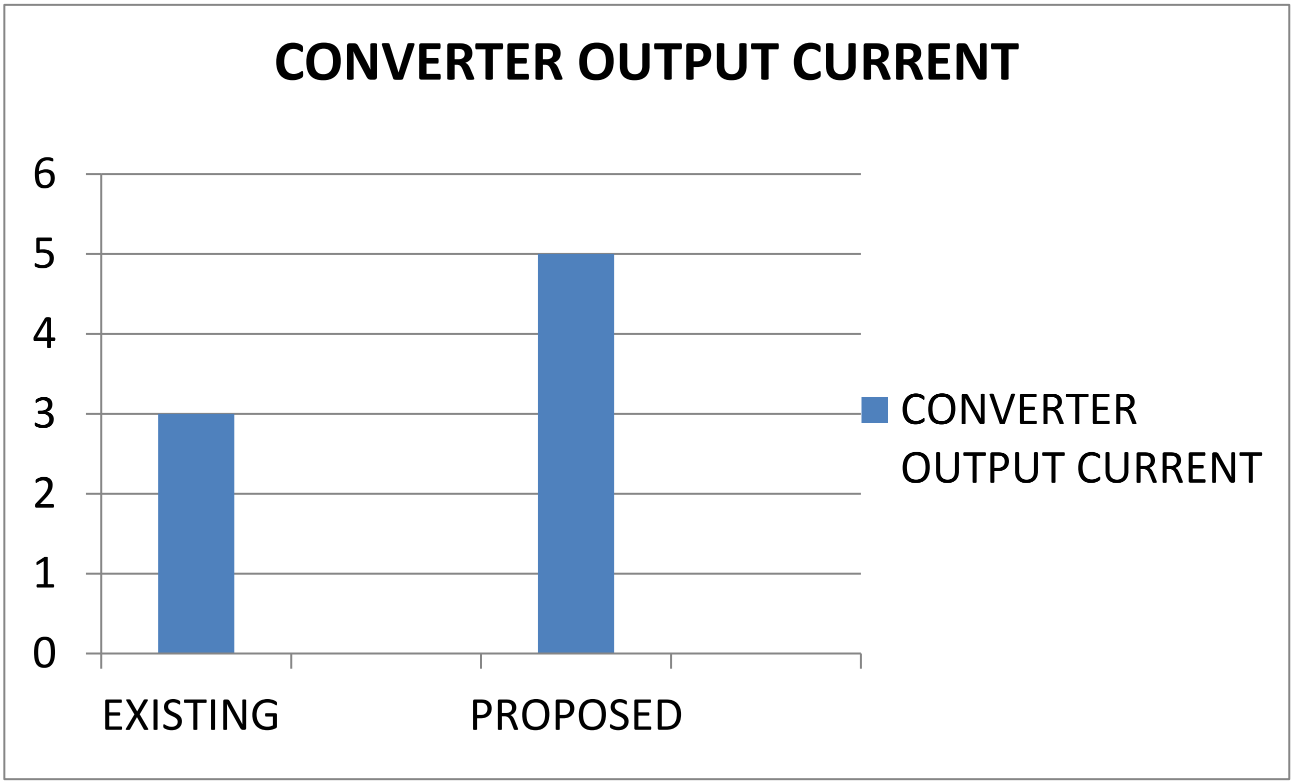

Figure 5.22 Comparison of Existing and Proposed method of Converter Output of RES

The converter input voltage in the proposed system will be 16 volts, whereas the current system's will be 12 volts, as shown in Figure 5.22 and the Figure 5.24. explains about the comparison of grid current in the existing will be 3 A. and the proposed system will be 6 A.

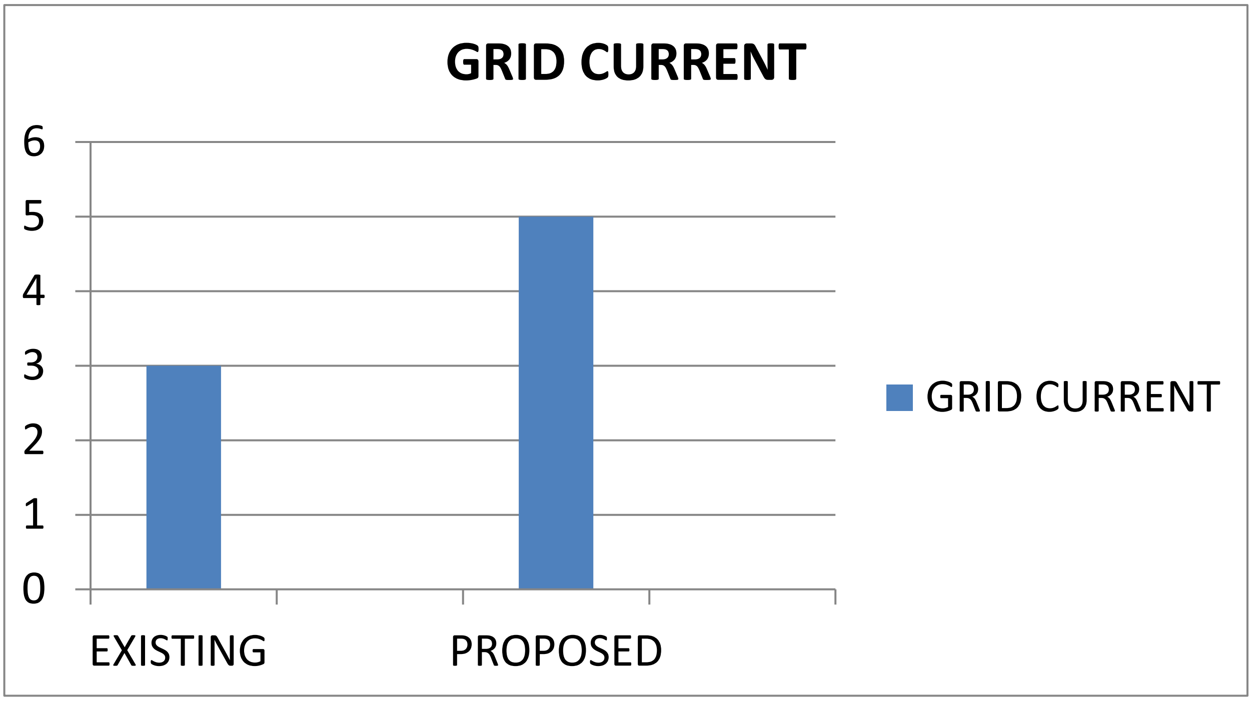

Figure 5.24 The Existing and Proposed method of Grid Current of RES

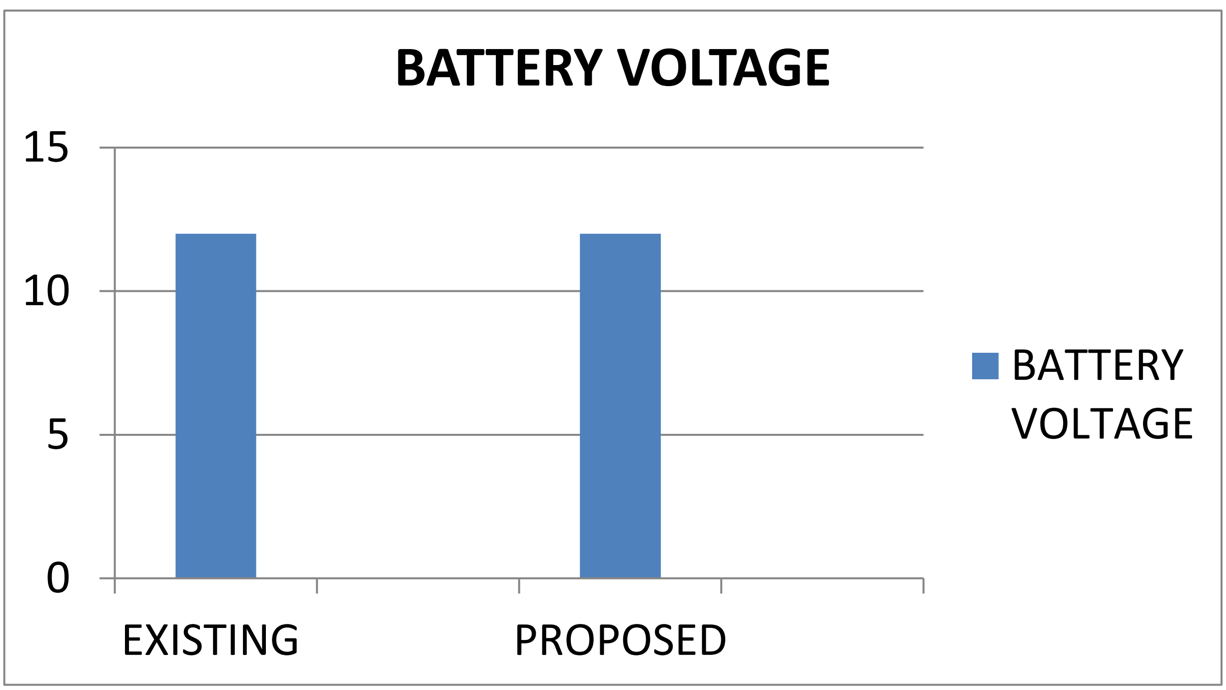

Figure 5.25 Comparison of Existing and Proposed method of Battery Voltage of RES

Figure 5.25 describes about the comparison of battery Voltage in the renewable energy source the existing will 12V and the Proposed will be 12V.

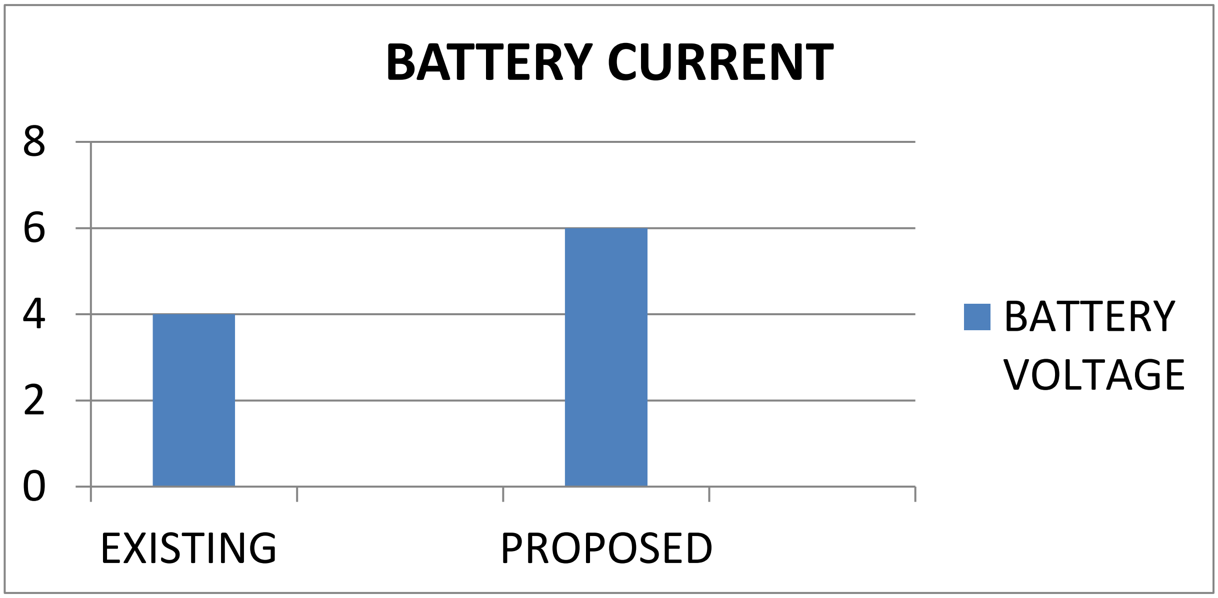

Figure 5.26 Comparison of Existing and Proposed method of Battery Current of RES.

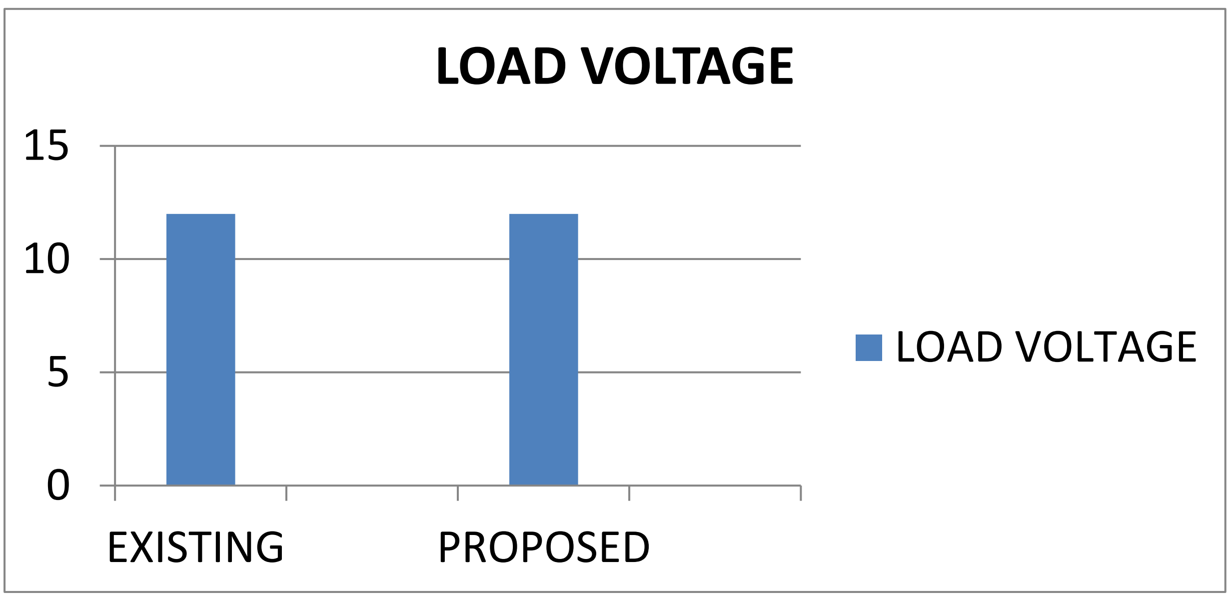

Figure 5.27 Comparison of Existing and Proposed method of Load Voltage of RES

Figure 5.26 describes about the comparison of battery Current in the renewable energy source the existing will 4 A and the Proposed will be 6A and the Figure

5.27 explains about the comparison of load Voltage in the renewable energy source the existing will 12V and the Proposed will be 12V.

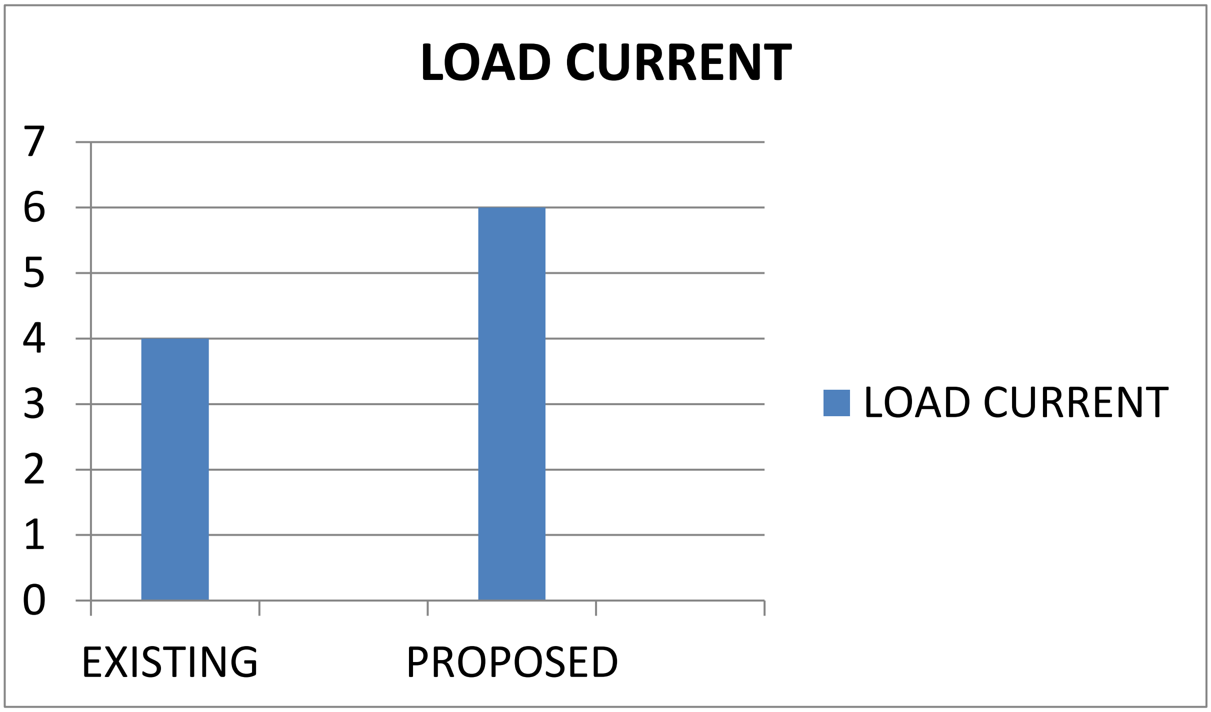

Figure 5.28 Comparison of Existing and Proposed method of Load Current of RES

Figure 5.28 describes about the comparison of load current in the renewable energy source the existing will 4 A and the Proposed will be 6 A.

5.10RESULTS AND DISCUSSION

The renewable energy source-fed battery storage system for vehicle-to-grid applications presents several advantages and potential benefits. Firstly, the use of renewable sources such as solar energy helps reduce carbon emissions, promoting a cleaner and greener environment. This aligns with global efforts towards sustainable development and mitigating the effects of climate change.

Additionally, by incorporating ultra-capacitors and DC to DC converters, the system can efficiently manage and store excess energy generated by renewable sources, which can then be used during peak demand periods. This enables energy self-sufficiency and reduces reliance on traditional fossil fuel-based energy sources.

Moreover, the integration of AI techniques in the system allows for enhanced efficiency and performance. AI algorithms can analyze energy patterns and optimize operations to ensure the most efficient use of renewable energy sources. This not only improves the overall performance of the system but also reduces operational costs and increases the lifespan of the components.

The bidirectional flow of energy between the grid and electric vehicles through V2G applications is another significant benefit of this system. This enables electric vehicles to act as mobile energy storage units, which can be utilized during peak demand periods or in emergencies. This not only promotes efficient energy utilization but also adds to the overall stability and reliability of the grid.

However, despite the numerous benefits of this concept, there are also potential challenges and limitations that need to be addressed. These include the high initial cost of implementation, the need for proper maintenance and monitoring, and ensuring regulatory and technical standards are met for safe and effective integration with the grid.

In conclusion, the renewable energy source-fed battery storage system for vehicle-to-grid application is a promising concept with vast potential in the renewable energy sector. By utilizing a combination of renewable sources, energy storage systems, and AI techniques, it presents a cost-effective and eco-friendly solution for efficient energy management. Further research and development in this area can lead to significant advancements, making this concept a crucial step towards a greener and more sustainable future.

CHAPTER 6

HARDWARE IMPLEMENTATION

6.1 INTRODUCTION

Hardware implementation refers to the process of physically constructing electronic circuits or devices based on designs developed in hardware description languages (HDLs) such as Verilog or VHDL. This process involves translating abstract designs into tangible hardware components that can perform specific functions or tasks.

Hardware implementation plays a crucial role in various fields, including computer engineering, embedded systems, digital signal processing, and telecommunications. It enables the creation of custom hardware solutions tailored to specific applications, offering advantages such as high performance, low power consumption, and real-time responsiveness.

1. Design: Hardware implementation begins with the design phase, where engineers create a detailed specification of the desired hardware functionality using HDLs or schematic capture tools. This involves defining the architecture, logic operations, and interconnections of the hardware components.

2. Synthesis: Once the design is complete, synthesis tools are used to convert the high-level hardware description into a netlist of logical gates and flip-flops that represent the desired functionality. During synthesis, optimizations may be applied to improve performance, reduce area, or minimize power consumption.

3. Verification: Verification is a critical step in hardware implementation to ensure that the synthesized design behaves as intended and meets the specified requirements. This involves simulation using test vectors, formal verification techniques, and hardware emulation to validate the design's correctness and

functionality.

4. Implementation: After verification, the synthesized design is translated into a physical layout consisting of interconnected electronic components such as integrated circuits (ICs), field-programmable gate arrays (FPGAs), or application-specific integrated circuits (ASICs). This step involves place-and-route algorithms to determine the optimal placement of components and routing of interconnections while meeting timing and resource constraints.

5. Testing: Finally, the hardware implementation undergoes testing to validate its functionality under various operating conditions and input stimuli. This may involve functional testing, performance testing, and reliability testing to ensure that the hardware meets the desired specifications and quality standards.

6.2 HARDWARE ON RENEWABLE ENERGY SOURCE USING BATTERY STORAGE SYSTEM

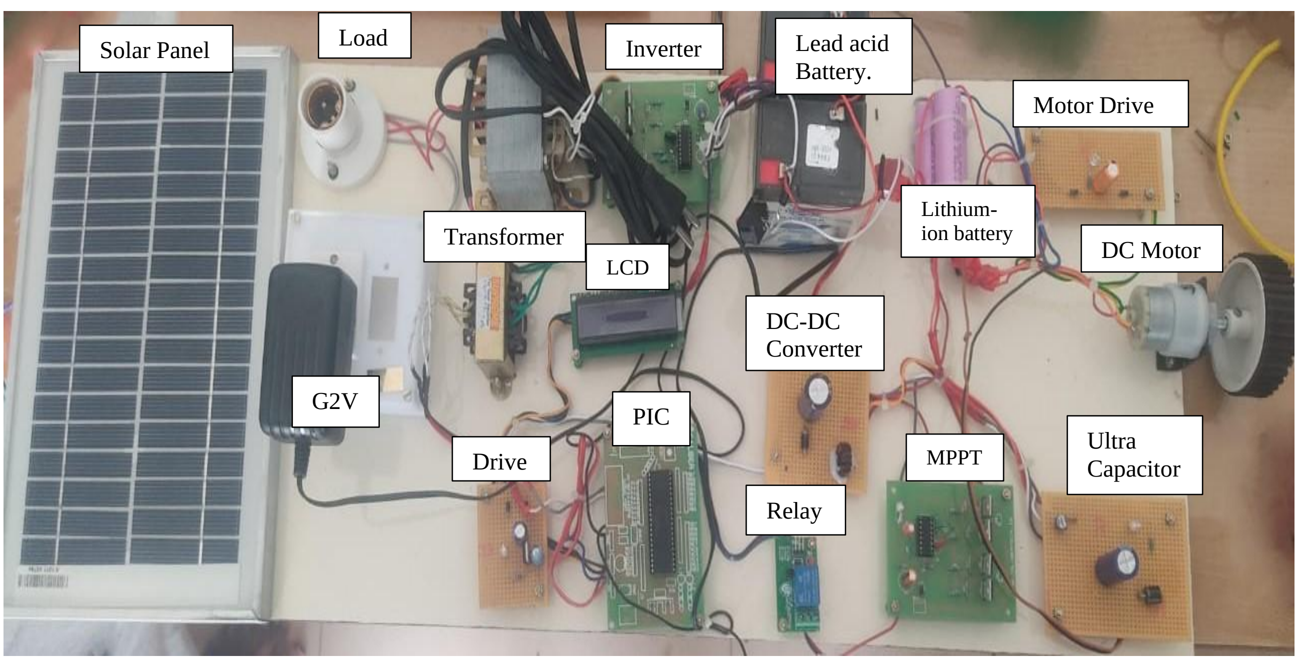

Figure 6.1 Hardware on Experimental Analysis of Renewable Energy Source Fed Vehicle to Grid Application Using AI Techniques

6.3 HARDWARE OUTPUT

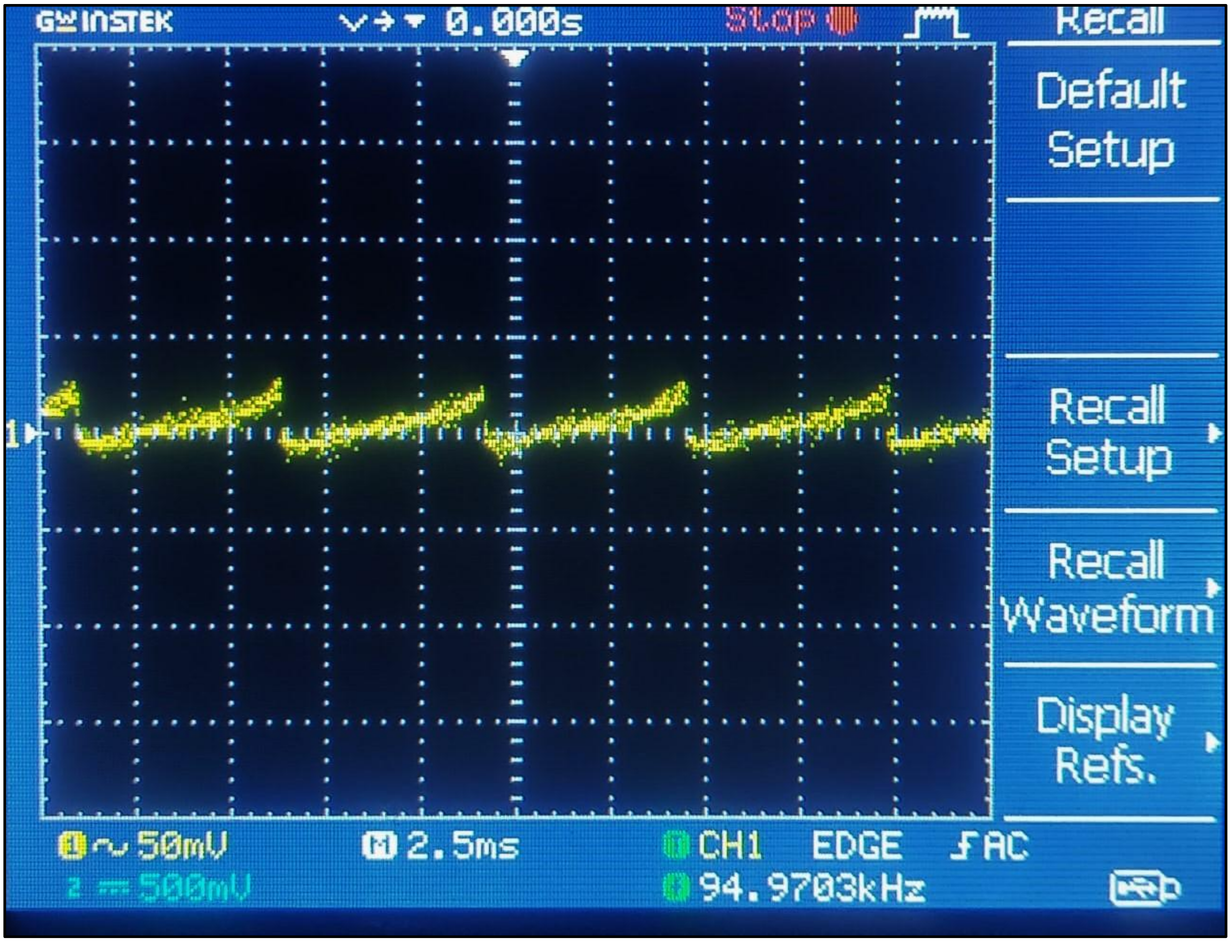

Figure 6.2 Output wave form of the DC-DC Converter during PV charging

Figure 6.2 explains about photovoltaic (PV) charging, a DC-DC converter is commonly used to regulate and optimize the power flow from the PV panels to the battery or load. The output waveform of the DC-DC converter during PV charging depends on several factors, including the converter topology, control strategy, and operating conditions. Here's a general description of the output waveform.

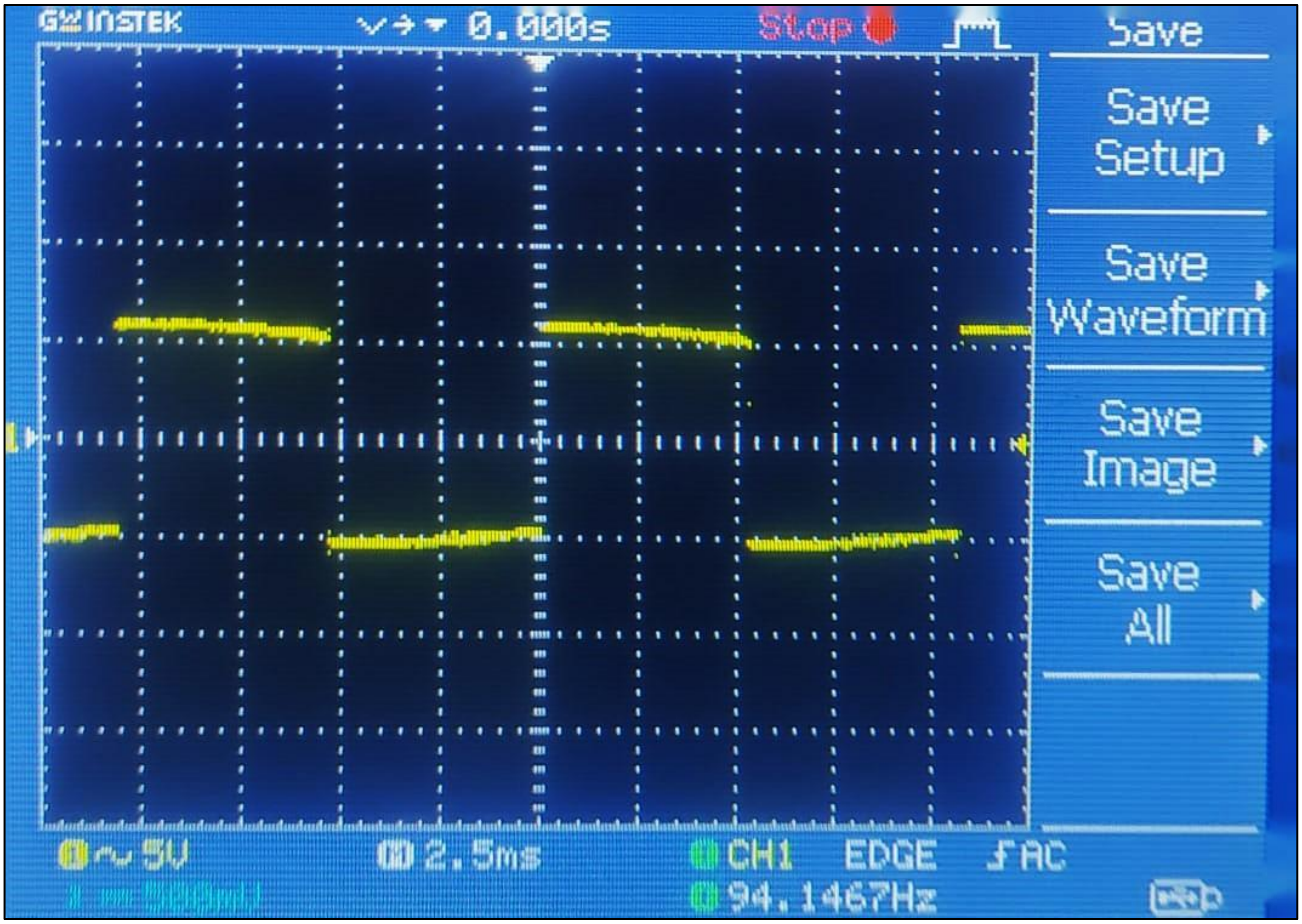

Figure 6.3 Output wave form of the Inverter during battery discharge

Figure 6.3 says about During battery discharge, an inverter is commonly used to convert the direct current (DC) from the battery into alternating current (AC) for powering electrical loads. The output waveform of the inverter during battery discharge depends on the inverter topology, control strategy, and the characteristics of the load. Here's a general description of the output waveform:

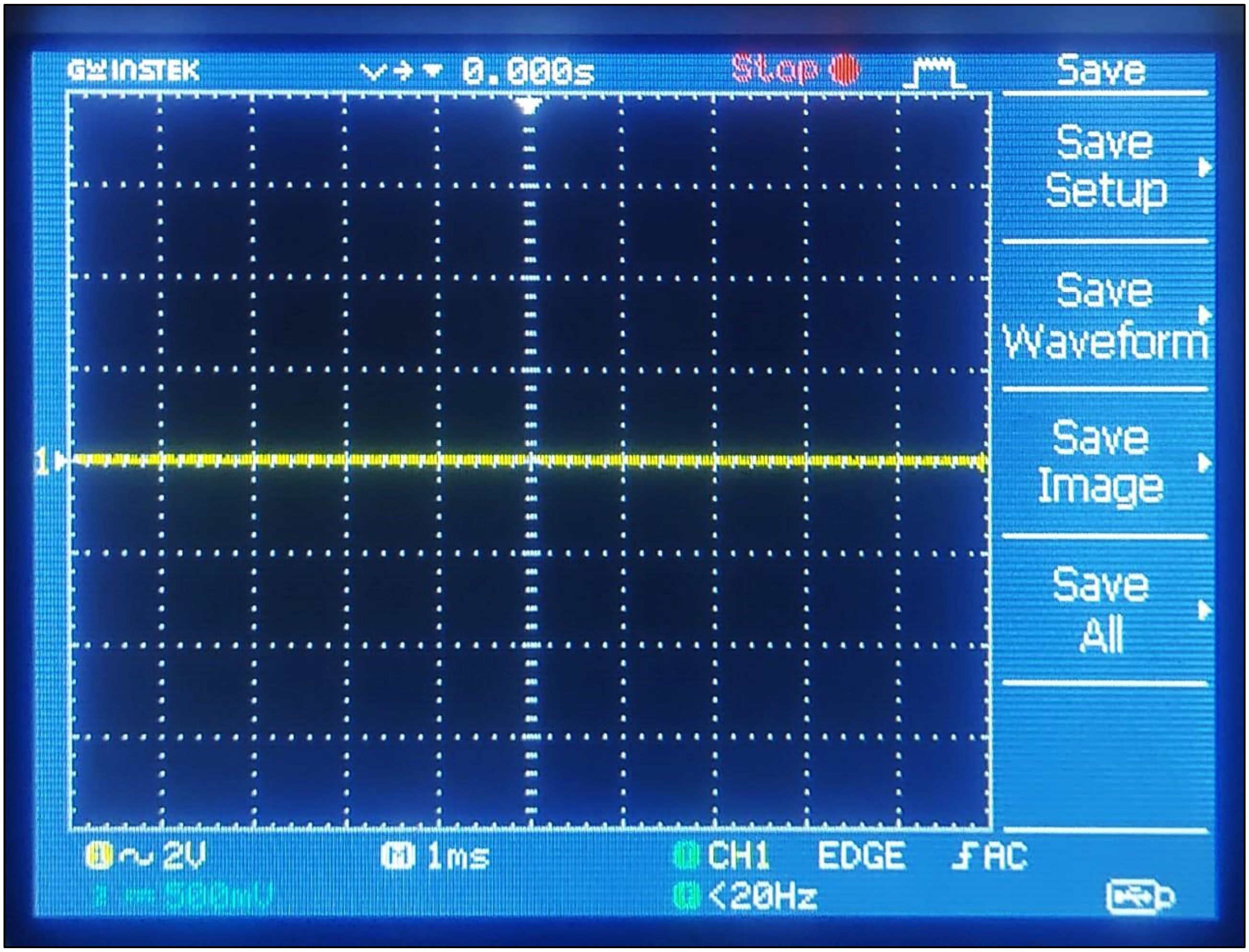

Figure 6.4 Output wave form of the ultra-capacitor during PV charging

Figure 6.4 describes about the photovoltaic (PV) charging, an ultracapacitor can be employed as a short-term energy storage device to capture and store energy from the PV panels. Unlike batteries, ultracapacitors can charge and discharge rapidly, making them suitable for applications requiring high-power bursts. The output waveform of the ultracapacitor during PV charging largely depends on the charging circuitry and control strategy. Here's a general description of the output waveform.

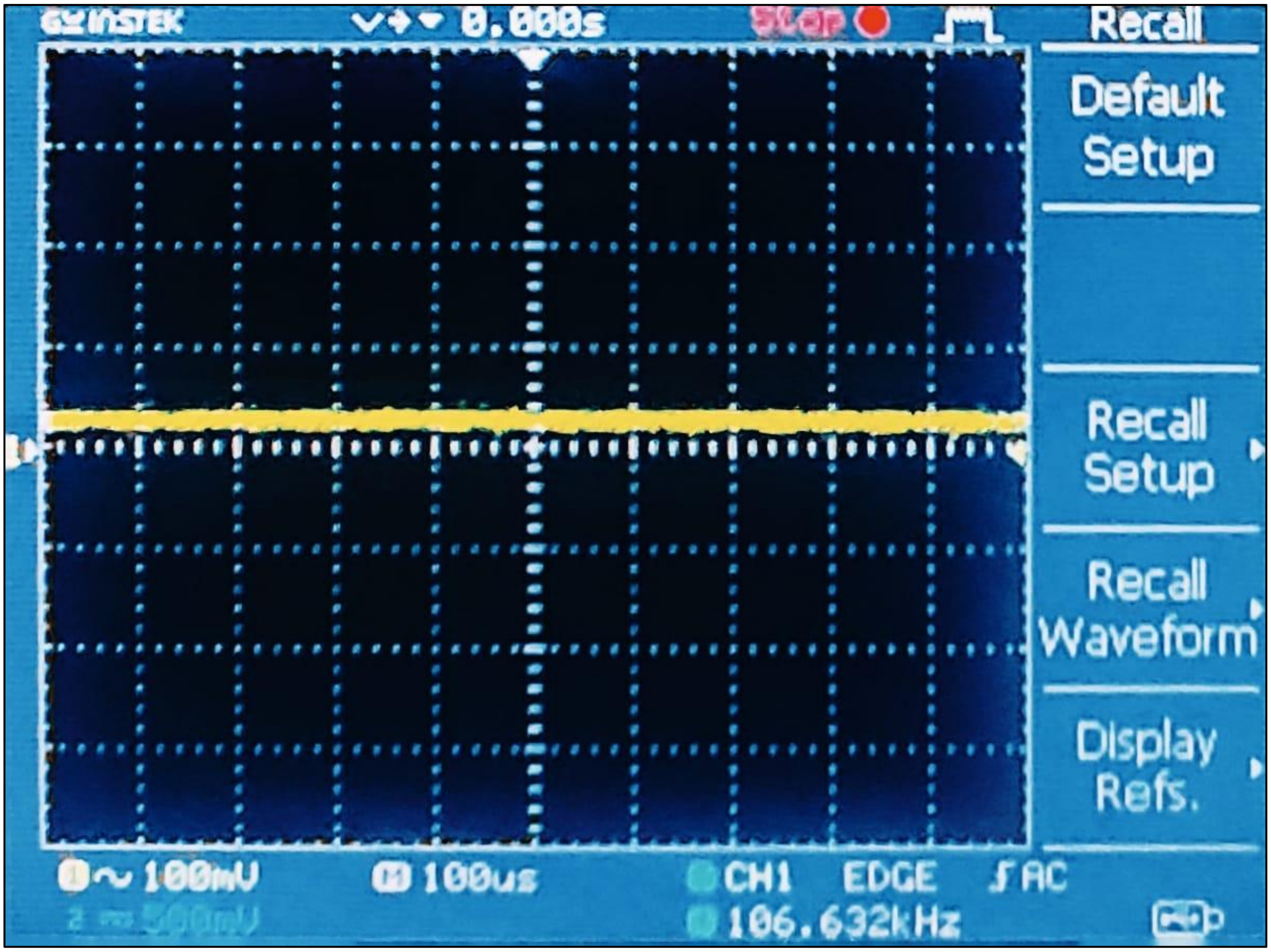

Figure 6.5 Output wave form of the MPPT during PV charging

Figure 6.5 describes about the output waveform of a Maximum Power Point Tracking (MPPT) controller during photovoltaic (PV) charging is not a conventional waveform like voltage or current; instead, it represents the tracking of the maximum power point (MPP) of the PV panels. Here's a description of how the MPPT operates during PV charging:

CHAPTER 7

CONCLUSION

Through the intelligent control algorithms enabled by AI, the V2G system demonstrates the potential to contribute to grid stability and reliability. The system effectively manages energy flows between vehicles, the grid, and storage, reducing the impact of intermittency associated with renewable sources. The utilization of renewable energy sources coupled with V2G technology contributes to reducing greenhouse gas emissions and promoting sustainable transportation. AI-driven algorithms play a crucial role in optimizing energy usage, thereby mitigating environmental impacts associated with conventional energy generation methods. he experimental results indicate that AI techniques can facilitate the scalability and adaptability of V2G systems to varying grid conditions and user behaviors. Machine learning algorithms enable the system to learn from historical data and dynamically adjust its operation, ensuring optimal performance under different scenarios. Despite the promising outcomes, challenges such as interoperability, standardization, and cybersecurity remain pertinent in the widespread adoption of V2G systems. Future research should focus on addressing these challenges while further refining AI-based control strategies to optimize system performance and enhance reliability.

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wind-photovoltaic system including battery energy storage with reducing control loops and omitting PV converter. *Journal of energy storage*, 27, 101088.

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and hydrogen vehicle storage. *Applied Energy*, 281, 116038.

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APPENDIX

```
// Example code for reading solar irradiance sensor
int readSolarIrradiance() {
  // Code to read sensor value
  int solarIrradiance = analogRead(solarSensorPin);
  return solarIrradiance;
}// Example code for data acquisition
int solarIrradianceValue = readSolarIrradiance();
// Example code for AI algorithm implementation (pseudocode)
float predictEnergyGeneration(int solarIrradiance) {
  // AI model prediction based on historical data
  // Example: Linear regression
  float predictedEnergy = slope * solarIrradiance + intercept;
  return predictedEnergy;
}           // Example code for battery management
void batteryManagement() {
  if (batteryVoltage > maxVoltage) {
    // Code to stop charging
  }
  if (batteryVoltage < minVoltage) {
    // Code to stop discharging
  }
}// Example code for MQTT communication
void sendDataMQTT(float data) {
  // Code to publish data to MQTT broker
```

Artificial Intelligence(AI) Algorithm in PIC Microcontroller

```
#include <16f887.h>
#fuses INTRC_IO, NOWDT, NOPUT, NOBROWNOUT, NOPROTECT
#device adc=10
#use delay(clock=4M)
#use rs232(baud=9600, xmit=pin_c6, rcv=pin_c7, bits=8,parity=N, ERRORS)
#use i2c(Master,Fast=100000, sda=PIN_c2, scl=PIN_c1,force_sw)
#include "caliberi2c.c"
float t1,t2,v1,v2,v;
unsigned int16 value;
int h=25,l=25;
void main()
{
setup_adc(ADC_CLOCK_INTERNAL ); // initialize ADC with a sampling rate of Crystal/4 MHz
setup_adc_ports(sAN0,sAN1);
setup_adc_ports(sAN2,sAN3);
setup_adc_ports(sAN4);
lcd_init();
  lcd_backlight_led(ON); //Backligth ON
lcd_init();
  printf(lcd_putc,"\fWELCOME ");
delay_ms(1000);
```

```
 output_high(pin_d0);
while(1)
{
set_adc_channel(0);
delay_ms(100);
t1 = read_adc();
delay_ms(100);
t1=20*(t1/1023);
delay_ms(100);
printf(lcd_putc,"\fEV BAT:%f "t1);
delay_ms(1000);
if(t1<9)
{
output_high(pin_d0);
printf(lcd_putc,"\f EV battery \n chrg.... ");
delay_ms(1000);
printf(lcd_putc,"\f g2v on ");
delay_ms(1000);
}
else
{
}
 if(t1>12.80)
{
output_low(pin_d0);
printf(lcd_putc,"\f EV battery \n chrg.... full ");
delay_ms(1000);
```

```
printf(lcd_putc,"\f g2v off ");
delay_ms(1000);
}
 else
 {
 }
 if(t1>12.80)
{
///output_low(pin_d0);
printf(lcd_putc,"\f v2g on ");
delay_ms(1000);
}
 else
 {
 }
}
}    }
}
```

LIST OF PUBLICATIONS

1. Dinesh Kumar. V, Jeeva. M, Kathiravan. K S, Barathiraja. .B and Sathish Kumar. S, "A Hybrid Renewable Energy Source fed Battery Storage System for Vehicle to Grid Application using AI Techniques," *2023 International Conference on Intelligent Technologies for Sustainable Electric and Communications Systems (iTech SECOM)*, Coimbatore, India, 2023, pp. 270-275, doi: 10.1109/iTechSECOM59882.2023.10434995. (Index in Scopus)

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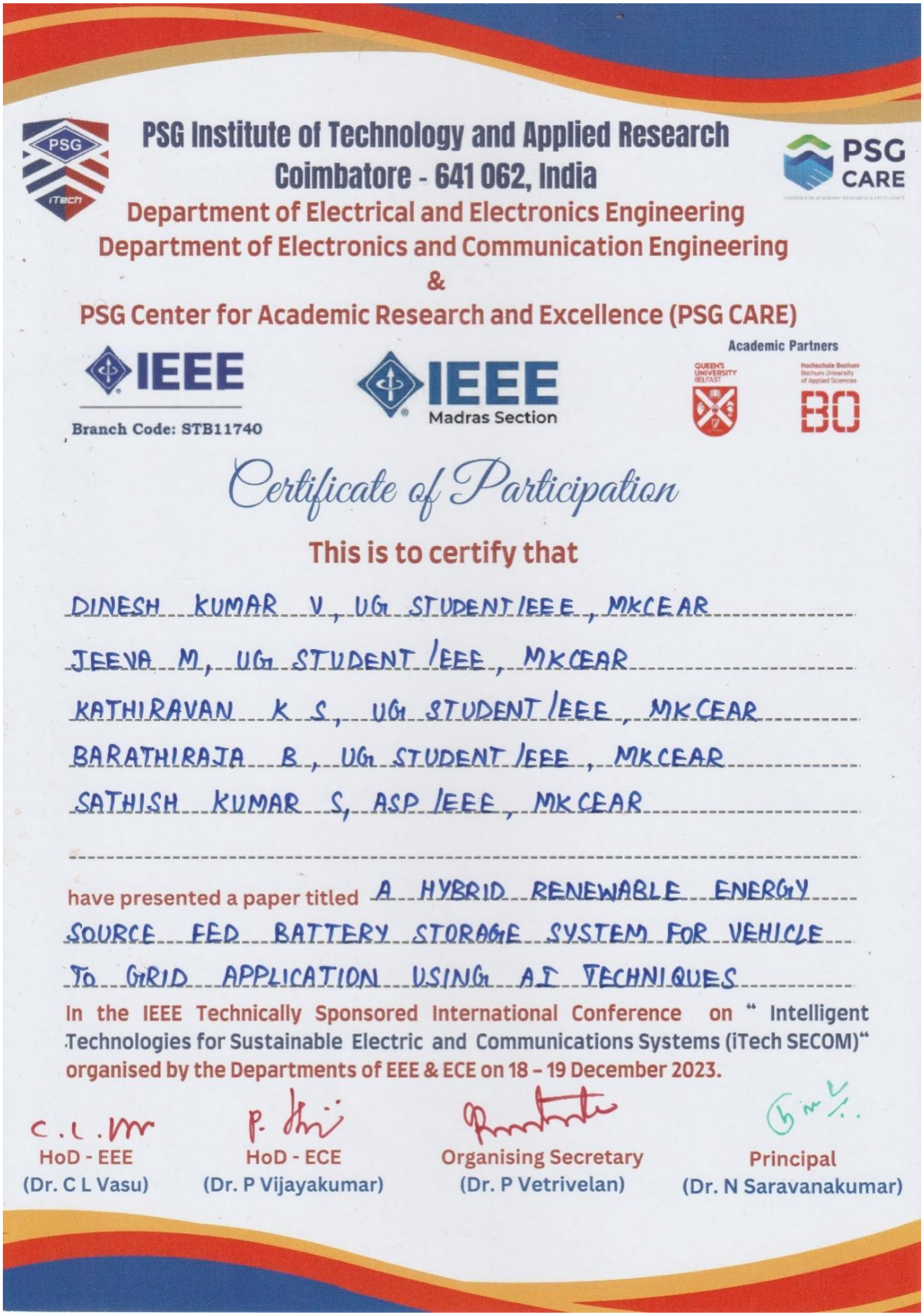

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Department of Electrical and Electronics Engineering
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KATHIRAVAN K S, UG STUDENT/EEE, MKCEAR

BARATHIRAJA B, UG STUDENT/EEE, MKCEAR

SATHISH KUMAR S, ASP/EEE, MKCEAR

have presented a paper titled A HYBRID RENEWABLE ENERGY SOURCE FED BATTERY STORAGE SYSTEM FOR VEHICLE TO GRID APPLICATION USING AI TECHNIQUES

In the IEEE Technically Sponsored International Conference on " Intelligent Technologies for Sustainable Electric and Communications Systems (iTech SECOM)" organised by the Departments of EEE & ECE on 18 – 19 December 2023.

HoD - EEE	HoD - ECE	Organising Secretary	Principal
(Dr. C L Vasu)	(Dr. P Vijayakumar)	(Dr. P Vetrivelan)	(Dr. N Saravanakumar)

A Hybrid Renewable Energy Source fed Battery Storage System for Vehicle to Grid Application using AI Techniques

Publisher: IEEE Cite This PDF

Dinesh Kumar V ; Jeeva M ; Kathiravan K S ; Barathiraja B ; Sathish Kumar S **All Authors**

Abstract:
The proposed system is a hybrid renewable energy source-fed battery storage system designed for vehicle-to-grid application that utilizes Artificial Intelligence (AI) techniques. The solar photovoltaic panel provides a renewable energy source, which is connected to a PIC microcontroller and AI for energy management based on the maximum power demand in the grid. This innovative system aims to integrate renewable energy sources with battery storage and AI technology, facilitating vehicle-to-grid operations. The use of AI technology promises to optimize battery life cycle data monitoring. To address rural areas disconnected from the grid, this PV system integrated with an ultra-capacitor represents among the most exciting sources of renewable energy sources available today. In addition, this proposed system can assist are not available. Furthermore, it may provide added benefits to consumers by lowering electric vehicle costs and increasing demand for Electric Vehicles through utilizing renewable sources to charge batteries based on maximum peak demand in the grid.

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