

Adaptive control of AI-Based Decentralized Control For Microgrid EV Charging Stations With Distributed Energy Resources

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ABSTRACT

The electrical vehicles have become the research focus for the environment- friendly characteristics in recent years. As the core technology of the EVs, the battery technology influences the development of the EVs. The desire for electric vehicles (EV) is rising as a result of efforts to reduce fuel consumption and improve air quality. The Energy Storage System (ESS) and converters in the Fast-Charging Station (FCS) with source of renewable energy will alleviate grid load and reduce carbon emissions. The hybrid energy storage system can increase the life span of the batteries by improving their working condition and how to shorten the charging time is also concerned. Two technologies are used in this project, one is Artificial Neural Network (ANN) method for fast charging of batteries and another one is energy storage is utilized to maintain the stability of the system.

The simulation outcome demonstrates that the proposed solution is used for an electric vehicle to charge.

KEYWORD - ANN, Artificial Neural Network, Perturb and Observe algorithm (P&O) and incremental inductance,

1. INTRODUCTION

In order to reduce the consumption of fossil resources and carbon emissions, electric vehicles and hybrid electric vehicles are widely promoted in the world. The fast charging station can increase the

charging rate and drive mileage of EVs. However, it adds the stress and new challenges on the utility grid. Therefore, the FCS based on the photovoltaic system is employed to alleviate the stress of the grid and reduce the carbon emission. PV technology is practical and cost-efficient. In general, the hybrid power supply system (HPSS) or FCS based on the renewable system uses the energy storage system (ESS), like the battery, super capacitor, flywheel, and so on, to eliminate the dynamic power fluctuation. For eliminating the dynamic power fluctuation Super capacitor is used in this project will be very obvious for FCS. Nonetheless, the previous energy management strategies are also adopted for the HPSS based on ESS, and ESS plays a crucial role in balancing the power flow. Without the power support of ESS, the traditional energy management strategies are no longer effective for the FCS. Meanwhile, the Artificial Neural Network (ANN) is proposed to improve efficiency of the converter side of the charging station, also super capacitor can balance the power fluctuations of FCS.

The multifunctional charger can work either in lattice associated mode or Island mode. The primary point of the task is to give supply to the homegrown EV with the utilization of electric vehicle and PV cluster. In network associated mode the EV and the homegrown burden burn-through power from the lattice alongside PV exhibit. In islanded mode both homegrown burden and EV use the charging of PV exhibit and in the event that the PV cluster isn't accessible, and the EV can give supply to the homegrown burden. At the point when both EV and PV exhibit are available then the force can be provided to the network after the usage of homegrown burden. This charger can be utilized to give

supply to various homegrown EVs and can oblige various EVs and can work like a Micro grids

I. RELATED WORKS

Rong Zeng, Veda Galigekere, Omer Onar and Burak Ozpineci, (2023) [1], Dynamic wireless charging for electric vehicles is an emerging technology to reduce on-board battery size and extend driving range. Due to its unique characteristic of vehicle-speed related pulse-like load profile, the high-power dynamic wireless charging system (DWCS) introduces high stress to the utility grid. In this paper, an optimization model for renewable energy integration in the DWCS is proposed to mitigate the grid impact and minimize the operation costs of the whole system. As the load profile of DWCS is related to the traffic volume and various approaching vehicle speeds, the annual average daily traffic data and a stochastic model are used to develop 24-hour load profile of DWCS. To find a tradeoff between grid impact mitigation and operation costs minimization, relationships among power demand from power grid, photovoltaic (PV) capacity, wind energy (WE) capacity and energy storage (ES) capacity are analyzed, and the optimization objective and constraints are developed. Numerical simulation results demonstrate that energy storage integration can greatly mitigate the grid impact of DWCS, and optimal ratio of PV and WE can significantly reduce the operation cost of DWCS.

Ayush Sen, Bhuvan Sharma, Darshan Ranka, Drishti Gupta, Yusuf Sharif., (2023) [2], The paper describes about the dynamic electric vehicle charging system from solar. It reduces fuel and pollution. Nowadays electric vehicle are growing in numbers because of high rates of fuel. Electric vehicle has now hit the road worldwide and are slowly growing in numbers. Also it is proven that electric vehicle helpful in reducing cost of travel and which is cheaper than fuel. So we have developed an electric charging system with unique ideas for solving charging system problem. In this electric vehicle no need of any wire, no need of external power supply, no need to stop vehicle for charging, we can charge EV in moving condition. In this system we use, battery, transformer, Atmega controller, LCD display, regulatory circuit, solar panel, coils of copper, AC to DC converters to develop the system more accurate. This whole system describes that how an electric vehicle can be charged in moving condition and also eliminating the need to stop the vehicle and charge it. Thus, insulating in the copper coil in the

road, we can charge the electric vehicle in the moving condition.

Sai Sudharshan Ravi and Muhammad Aziz.,(2022) [3], **With every passing second, we witness the effect** of the global environmental impact of fossil fuels and carbon emissions, to which nations across the globe respond by coming up with ambitious goals to become carbon-free and energy-efficient. At the same time, electric vehicles (EVs) are developed as a possible solution to reach this ambitious goal of making a cleaner environment and facilitating smarter transportation modes. This excellent idea of shifting towards an entirely EV-based mobility industry and economy results in a range of issues that need to be addressed. The issues range from ramping up the electricity generation for the projected increase in consumption to developing an infrastructure that is large enough to support the higher demand for electricity that arises due to the market penetration of EVs. Vehicle to grid (V2G) is a concept that is largely in a testing phase in the current scenario. However, it appears to offer a solution to the issues created by a mobility sector that the constantly growing EV fleet will dominate. Furthermore, the integration of EVs with the grid seems to offer various cost-wise and environment-wise benefits while assisting the grid by tapping into the idle energy of parked EVs during peak hours. This review aims to present some of the possible ancillary service potentials of such a system while also discussing the potential challenges, impacts, and future market penetration capabilities of V2G technology.

Cheng Qifu, Chen Lei, Sun Qiuye, (2020) [4], With the growing popularity of electric vehicles (EV), there is an urgent demand to solve the stress on grid that are caused by irregular and frequent access of EVs. The traditional direct current (DC) fast charging station (FCS) based on photovoltaic (PV) system can effectively alleviate the stress of grid and carbon emission, but the high cost of the energy storage system (ESS) and the underutilization of grid-connected interlinking converters (GIC) are not well addressed. In this paper, the DC FCS architecture based on PV system and ESS-free is firstly proposed and employed to reduce the cost. Moreover, the proposed smart charging algorithm (SCA) can fully coordinate the source/load properties of the grid and EVs to achieve the maximum power output of PV and high utilization rate of GICs in the absence of ESS support for FCS. SCA contains a self-regulated algorithm (SRA) for EVs and a grid-regulated

algorithm (GRA) for GICs. While the DC bus voltage change caused by power fluctuation does not exceed the set threshold, SRA readjusts the charging power of each EV through the SOC feedback of EV, which can ensure the power rebalancing of FCS. The GRA would participate in the adjustment process once the DC bus voltage is beyond the set threshold range. Under the condition of ensuring the charging power of all EVs, GRA based on adaptive droop control can improve the utilization rate of GICs. At last, the simulation and experimental results are provided to verify the effectiveness of the proposed SCA.

Ayyappan Subramaniam, Lal Raja Singh Ravi Singh., (2023) [5], India's expanding population has necessitated the development of alternate transportation methods with electric vehicles (EVs) being the most indigenous and need for the current scenario. The major hindrance is the undue influence on the power distribution system caused by incorrect charging station setup. Renewable Energy Sources (RES) have a lower environmental impact than the non-renewable sources of energy and due to which Plug-in Hybrid Electric Vehicles (PHEV) charging stations are installed in the highest-ranking buses to facilitate their effective placements. Based on meta-heuristic optimization, this study offers an effective PHEV charging stations allocation approach for RES applications. The primary objective of the developed system is to create a charging network at a reasonable cost while maintaining the operational features of the distribution network. These trouble sare handled by applying meta-heuristic algorithms and optimum planning based on renew able energy systems to satisfy the outcomes of the variables. As a result, by adding charging station parameters, this research proposes to conceptualize the distribution of opti mal charging stationsas multiple-objectives of the problem. Furthermore, the PHEV RES and charging station location problem is handled in this study by deploying a novel hybrid algorithm termed as Atom Search Woven Aquila Optimization Algorithm (AT- AQ) that includes the ideas of both Aquila Optimizer (AO) and Atom Search Optimization (ASO) Algorithms. In reality, Aquila Optimizer is a unique population-based optimization approach energized by Aquila's behaviour when seeking prey and it solves the problems of slow convergence and local optimum trapping. According to the findings of the experiments, the pro posed model outperformed the other methods in terms of minimized cost function.

AKhtar Hussain, Van-Hai Bui, et al., (2020) [6], proposed an Optimal Sizing of Battery Energy Storage System in a Fast EV Charging Station Considering Power Outages. To determine the optimal size of an energy storage system (ESS) in a fast electric vehicle (EV) charging station, minimization of ESS cost, enhancement of EVs' resilience, and reduction of peak load have been considered in this article. Especially, the resilience aspect of the EVs is focused due to its significance for EVs during power outages. First, the stochastic load of the fast-charging station (FCS) and the resilience load of the EVs are estimated using probability distribution functions. This information is utilized to maintain the energy level in the ESS to ensure the resilience of EVs during power outages. Then, the annualized cost of the ESS is determined using the annual interest rate and lifetime of ESS components. Finally, the optimal ESS size is determined using the annualized ESS cost, penalty cost for buying power during peak hours, and penalty cost for resilience violations. Simulations along with sensitivity analysis of uncertainties (market price, arrival time of EVs, and the residual energy level of EVs), number of EVs in the FCS, and converter ratings are conducted. Simulation results have shown that increasing the penalty cost for peak intervals is a viable solution to decrease the peak load while controlling the cost of the FCS.

II. PROPOSED MODEL

By coordinating the power distribution of EVs, the Artificial Neural Network(ANN), which is proposed in this paper, attempts to accomplish with ESS in FCS. The FCS power fluctuation range is well represented by the DC bus voltage. Figure 3.1 shows the block diagram of the Fast Charging Station of Electric Vehicle. The use of super capacitor will be minimized as a result of frequent power fluctuations because of the special temporal and dynamic load characteristics of EVs. The Artificial Neural Network used by the converters for improving the efficiency. It aids the converter in controlling the power supply to the electric vehicle battery during both charging and draining. This work employs ANN to control the charging power of EVs in order to prevent minute power oscillations in FCS because the charging period of EVs is at the hour level.

- The framework associated mixture sustainable framework is acknowledged by discrete voltage source converters and battery reinforcement framework in order to infuse nonstop capacity to the matrix.

- Free and strong controls of MPPT of the introduced sustainable sources are performed by basic ANN regulator.
- A bidirectional converter constrained by ANN regulator is utilized to keep up with steady voltage at the PCC.
- The state-space model of the exchanged Z-source converter is created to examine the framework dependability, and the reenacted viability of the general framework is approved by fostering the model of the framework.
- A shrewd dispatch framework is needed to control the force dispatch from battery unit [26]. As the heaps associated with the network are dubious and are at risk to fluctuate, customary battery the board conspire can't be used to oversee power stream among the battery and matrix. The current regulators supply the whole force of the battery to the framework

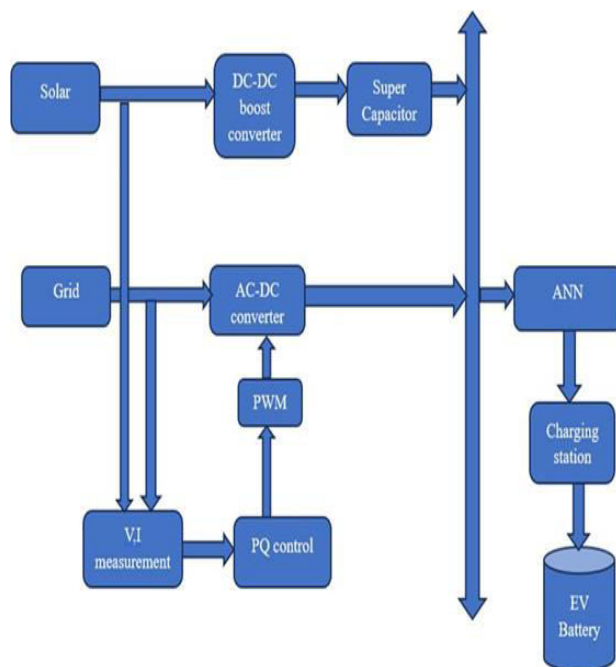


Fig 1: Proposed System Representation

A shrewd dispatch framework is needed to control the force dispatch from battery unit [26]. As the heaps associated with the network are dubious and are at risk to fluctuate, customary battery the board conspire can't be used to oversee power stream among the battery and matrix. The current regulators supply the whole force of the battery to the framework if the heap esteem increments and the battery might empty out totally. In the event that this interaction proceeds, the battery life

expectancy limited which thus causes blackout and diminishes the dependability of whole framework. In this manner, it is fundamental for carry out brilliant regulators for effective administration of battery framework [27,28,29,30]. The yields of converters of PV and wind sources and battery are associated at the normal coupling point where a consistent DC voltage is kept up with the proposed framework. This voltage is coupled to the network through 3 ϕ voltage source inverter (VSI) and channel circuits. As staggered inverter [31, 32] and z-source inverter [33, 34] business makes the circuit unpredictable and exorbitant and diminishes the framework effectiveness, a customary VSI with LC channel is carried out in our framework. Also, half breed framework works with coherence in power stream, along these lines further developing the unwavering quality [24, 25]

A. Artificial Neural Network

An Artificial neural organization is a computational model emulating the natural neural organization [23]. In a particularly model, a neuron is a handling unit that first straightly gauges the information sources, then, at that point expounds the total through a nonlinear capacity, called initiation work (AF) and, at last, sends the outcomes to the accompanying neurons [24]. The model of a typical neuron is given by the relationship (4), where z is the contention of the AF, as displayed in Fig.4

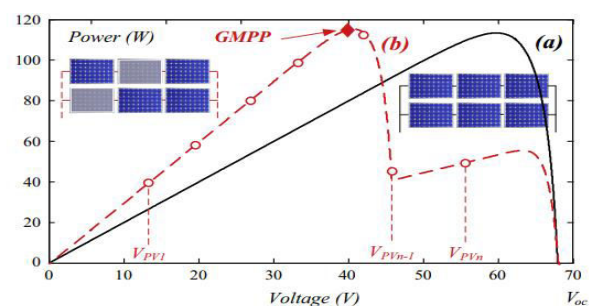


Figure 2: Characteristics of P-V

also, $x_1, x_2, \dots, x_M$ are the M approaching signs, and $w_1, w_2, \dots, w_M$ are the connected neurotransmitters EVs. Distinctive AFs have been proposed in writing [25] like edge, direct and

Fundamentally, the ANN can be addressed by a coordinated chart where the hubs and the edges are, separately, the neurons and the neurotransmitters [31]. Two unique fundamental sorts of ANN's design emerge from the manner in which the neurons are associated with one another: feed forward neural organization (ANN) [32] and repetitive neural organization (RNN) [33]. The construction of a multi-facet ANN considered in the proposed application is portrayed in Fig. 5, where the neurons of the information layer acts just as cushions for conveying the information signals (VPV, IPV). The yield layer has one neuron giving the voltage esteem VEMMPA relating to the EMPPA. The considered ANN has been prepared by utilizing the back propagation (BP) calculation with the Levenberg-Marquardt enhancement technique [29].

plan to prepare the ANN by giving it a few mixes of wanted arrangements and the connected worth of the information sources. Right away, the EVs are, normally arbitrarily, set. Then, at that point a managed learning strategy is applied to appropriately adjust the EVs, to decrease the mistake between each ideal yield design and the arrangement gave by the ANN to the connected info design. In the proposed application, at each phase of the learning cycle, the ideal yield design is the voltage esteem identified with the GMPP and the information designs are the upsides of VPV, IPV at the n focuses where the P-V trademark is assessed for a particular arrangement of sun based irradiance dispersion and boards temperature.

III. RESULT DISCUSSION

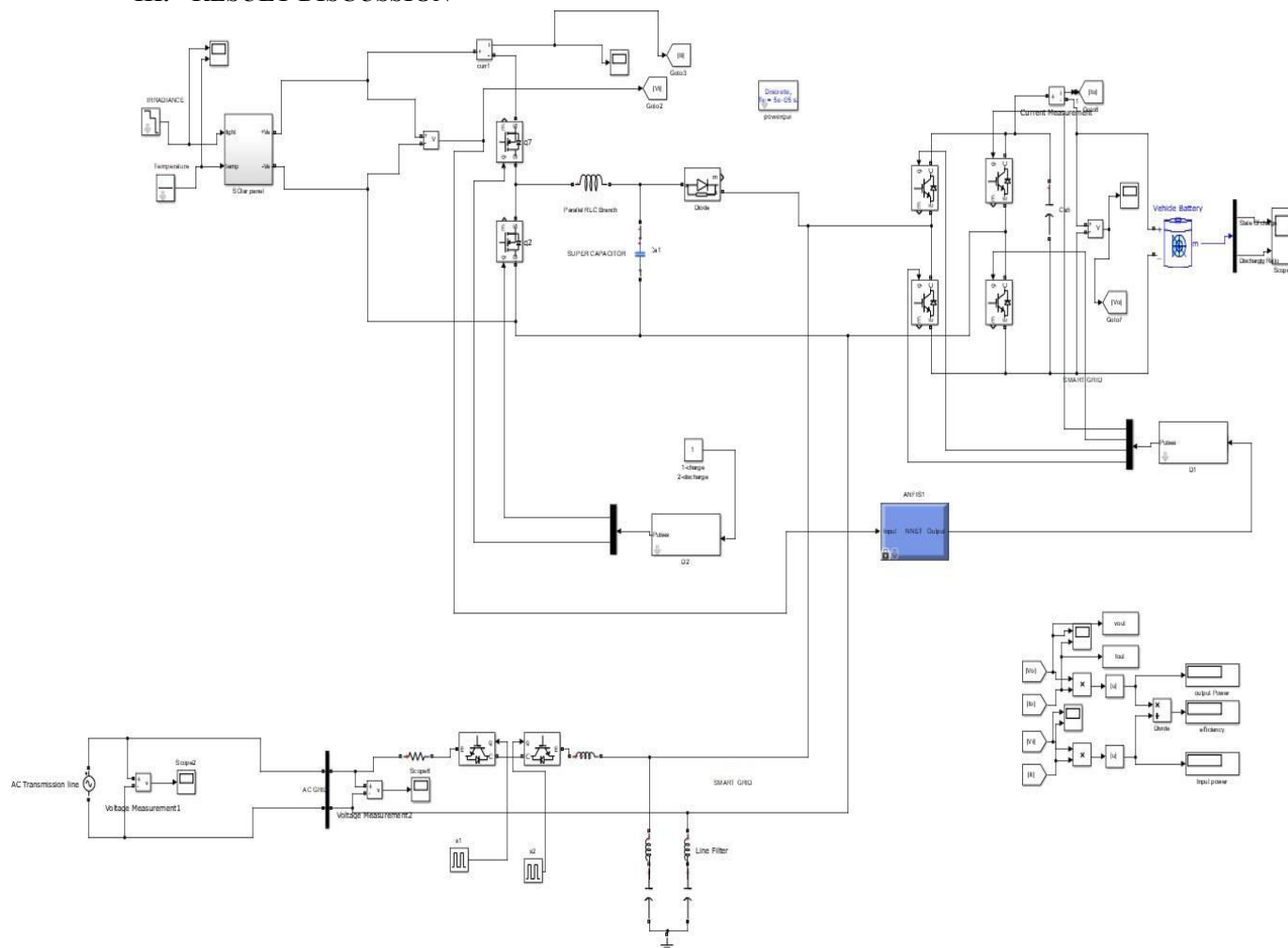


Figure 3: SIMULATION MODEL OF OUR SYSTEM

The following figures display the results of the simulation and an analysis of the solar panel, converter, battery, inverter, grid, and charging time using ANN. Figure 5.1 displays the solar panel output following the use of a dc-dc boost converter.

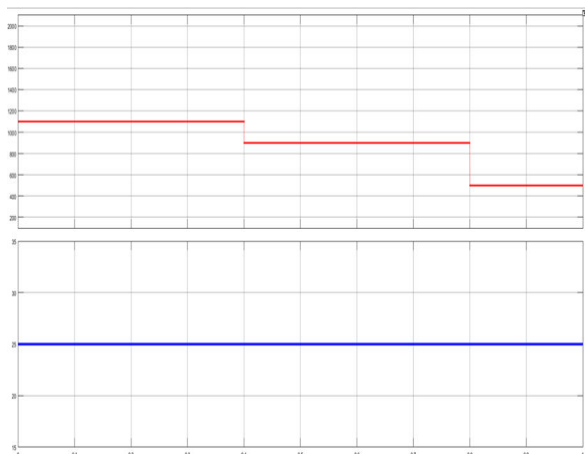


Figure 4: Solar Output

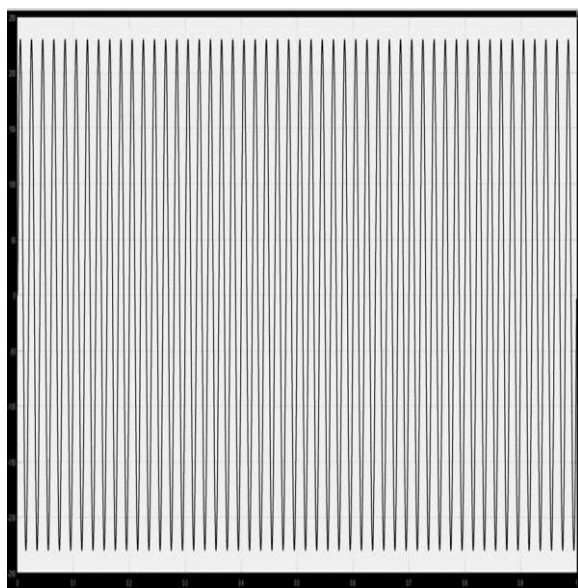


Figure 5: Grid Voltage

The power taken from the grid to charge the battery of electric vehicle by using Artificial Neural Network is shown in the Figure 5.2. The power is drawn from the grid.

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in the Figure 5.3. The power is drawn from the grid AC to DC Converted Output from Grid.

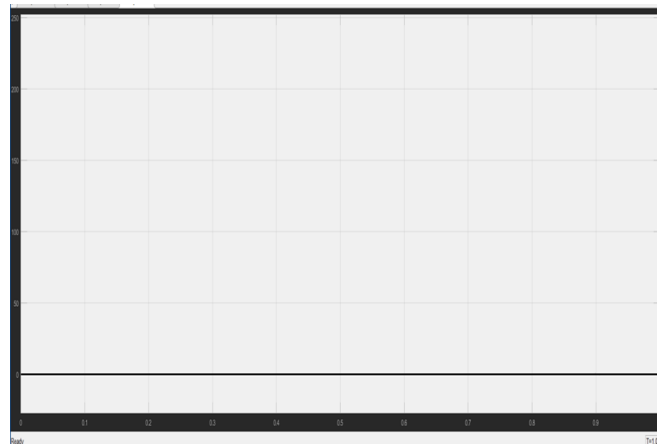


Figure 6: AC to DC Converted Output from Grid.

The Artificial Neural Network can also for the calculate the efficiency in the converter side for the battery, in the efficiency calculator also available. ANN used for improve the efficiency above 90 percentage. Figure 5.4 The ANN efficiency calculator.

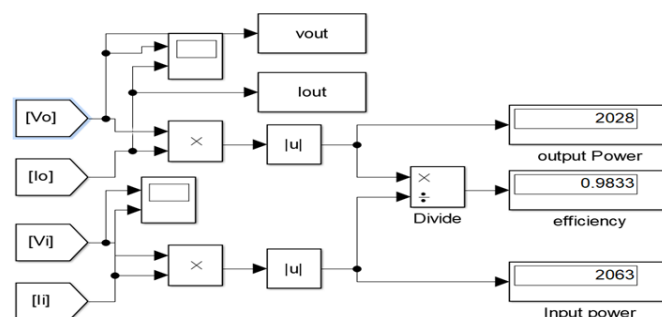


Figure 7: Efficiency Calculator

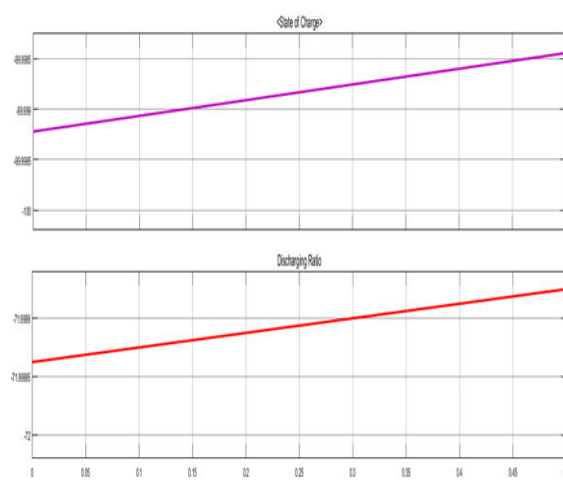


Figure 8: Battery Output

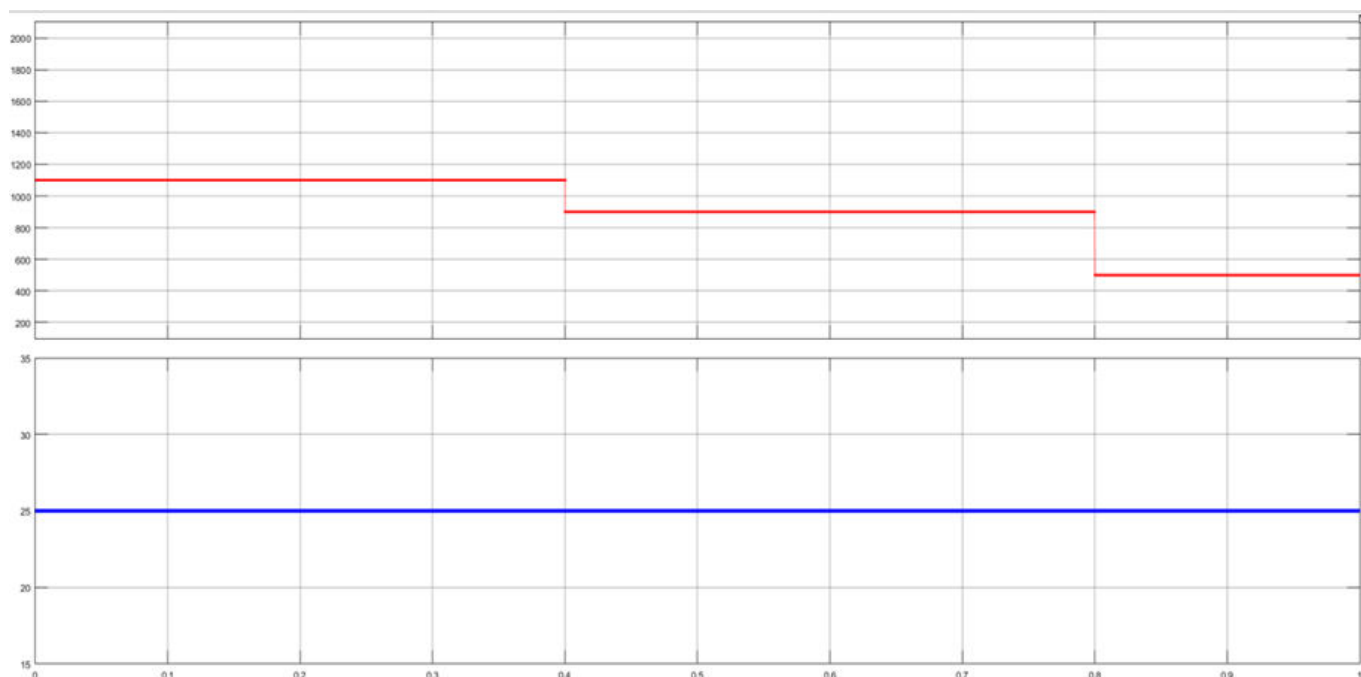


Figure 10: output of PV

The simulation results of the proposed system which has the output waveforms of solar power, grid voltage, output of battery and State of charge (SOC). The bidirectional converter provides the set value to the Artificial Neural Network. The battery is charged using a source, such as the grid or solar electricity. Reducing the time required for an electric car to charge is the major goal of this technique. Utilizing an Artificial Neural Network, this was accomplished. Figure 5.6 depicts a Charging and Discharging of Battery. of battery is utilized by Artificial Neural Network (ANN) with MATLAB software, were shown and discussed in this chapter.

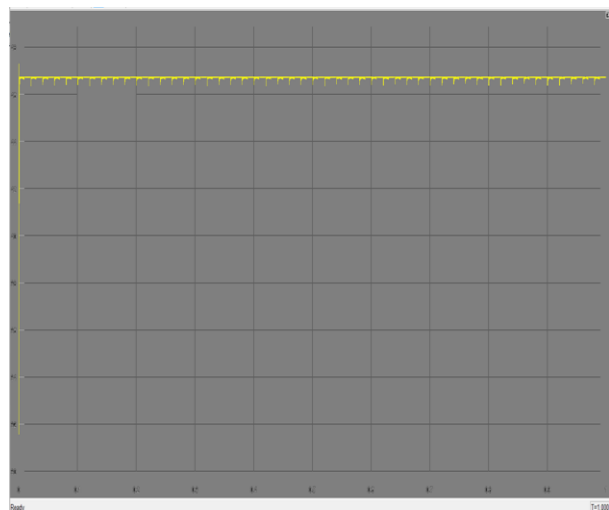


Figure 10: High efficiency input to the battery

The Efficiency calculator calculates the input efficiency to the battery and improves that efficiency into high efficiency and then gives it to the battery. Figure 6 shows high efficiency input to the battery.

CONCLUSION

Improved GIC consumption and ESS are essential components of FCS based on HPSS. An ANN built on the improved efficiency model is suggested for FCS. The value of the suggested approach is illustrated through simulation. To balance power fluctuations brought on by PV system intermittency and EV irregular access, a super capacitor is used to balance fluctuations. The charging and discharging currents of the battery are adjusted by the bidirectional converter. Using an Artificial Neural Network, it chooses the battery's power source for electric vehicles. The efficiency of ANN is measured by the amount of time it takes to charge the battery of an electric vehicle. Also, the ANN has an efficiency calculator. The charging station can be used to charge the electric vehicles with plug-in. Additionally, we draw the conclusion that compared to other charging methods, the Plug-in charging method takes short time to charge a battery.

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