Renewable Energy Based Isolated EV Charging Station

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Abstract: Very recently, Electric vehicles are rapidly gaining popularity as they're an eco-friendly alternative to gasoline-driven cars. According to a report rapid growth of 54% from 2016 to 2017. Studies also suggest that Electric Vehicles (EV), as compared to fossil fuel cars, have considerably lower greenhouse gas emissions that can even be brought right down to zero, provided green electricity is employed for charging EVs'. Access to green electricity is additionally becoming a reality thanks to the paradigm shift within the global energy generation landscape. This topic is to propose an EV charging strategy in isolated distribution systems, such as Off-grid Micro-grids, based on the optimization of the charging process and subject to the grid constraints. Furthermore, the methodology gives rise to increasing the use of available RES and resulting in a future increase of renewable energy production and reduction of CO2 emissions.

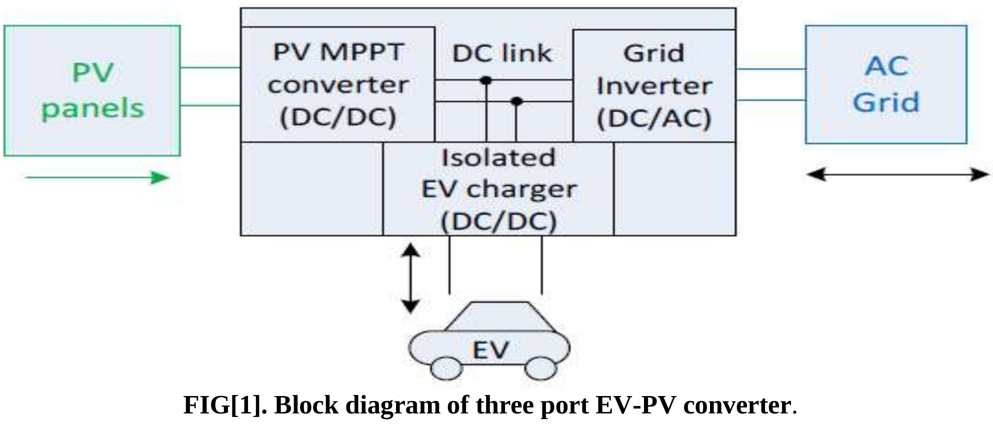
***Index Terms*- Electric vehicles, PV panels, Zeta converter, Interleaved Fly back converter, wind turbine.**

I. Introduction

Electric vehicles (EVs) are considered to be the longer-term mode of transportation. They are more efficient and have no emissions when compared to fossil fuel-powered vehicles. Currently, electric vehicles are charged from the grid whose fuel mix is especially dominated by fossil fuels. In order to form EVs sustainable, it's essential to charge EVs from sustainable sources of electricity. Hence, the charging of EVs from photovoltaic (PV) panels may be a sustainable proposition for the future. At an equivalent time, PV generation is characterized by both diurnal and differences due to the season. This necessitates a grid connection to make sure a reliable power supply for charging the EVs. Workplaces like office buildings, factories, and industrial areas are ideal places to facilitate solar EV charging where the building rooftops and car parks are often installed with photovoltaic (PV) panels.

Proposed Topologies: In this topic, we compared two topologies i.e. three-port EV-PV converter compared with V2G dynamic regulation model with the wind.

II. First Topology: Three Port EV-PV Converter



FIG[1]. Block diagram of three port EV-PV converter.

As shown in the above fig1 block diagram the voltage from PV panels is given to the PV MPPT converter. For this, we design the zeta converter which can give the desired output voltage.

PV Fed Zeta Converter: Zeta converter is a fourth-order DC-DC converter that is used for increasing or reducing the voltage at different levels without inverting the polarities. The rationale being is that it includes two capacitors and two inductors as dynamic storage elements as shown in fig2 below. Compared with Cukor Sepic converters, the Zeta converter has received the tiniest amount of attention. A zeta converter could even be a fourth-order non-linear system being that, regarding energy input, it is often seen as the boost-buck-boost converter.

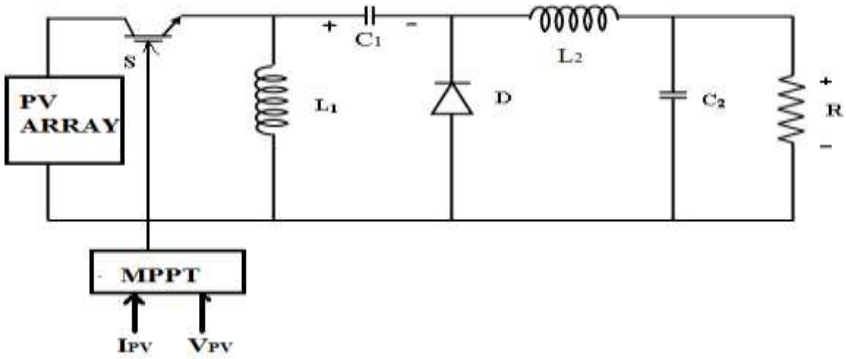


FIG.[2] PV fed zeta converter

The PV panel converts radiation into electrical power that's fed to the ZETA DC-DC converter. A maximum point tracker (MPPT) is employed for extracting the utmost power from the solar PV module and transferring that power to the load as shown in fig3. the height power is reached with the help of a DC-DC converter by adjusting its duty cycle such the resistance just like the height power is obtained. Automatic tracking is often performed by utilizing Perturb & Observe (P&O) algorithm. The algorithm changes the duty cycle of the DC-DC converter to maximize the power output of the module and make it operate at the peak point of the module.

i) Simulation for PV fed zeta converter

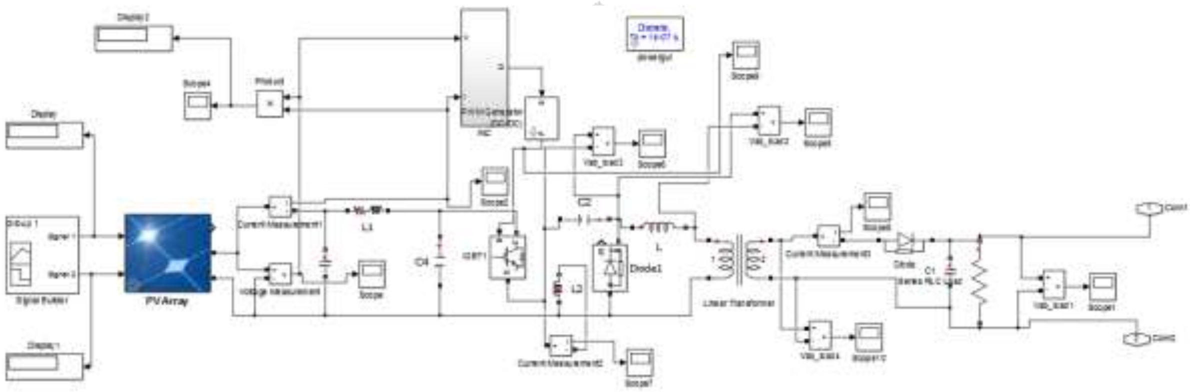


FIG.[3] Simulation for PV fed zeta converter

As shown in fig3, the generated signals are given to the PV array. That means we get the output of the PV array. Now we have to boost or amplify this output. For boosting the voltage, a Zeta converter is implemented. One IGBT switch is connected across the shunt inductor. The maximum power point tracker is used to keep the throughout voltage constant. For this, we use the duty cycle of 40%. By adjusting the duty cycle, the MPPT gives us a constant voltage. If the current into the system decreases or less than zero then the duty cycle increased. And if the current is greater than zero then the duty cycle decreased. Such that we get constant output. For non-reversing action of current, one diode is connected parallel. In this algorithm, a small perturbation is introduced by the MPPT system. Due to this perturbation, changes the facility of the module. If the facility increases thanks to the perturbation then the perturbation is sustained therein direction. After the height, power has reached the facility at subsequent instant decreases and hence then the Perturbation reverses. When the steady-state is reached the algorithm oscillates around the peak point. To stay the facility variation small the perturbation size is kept very small. The algorithm is developed in such a fashion that it sets a reference voltage of the module like the height voltage of the module.

ii) Simulation for three port EV-PV converter

The voltage generated from the PV array is stored in the battery. The stored voltage is given to the Three-phase inverter through the interleaved stages. For this interleaved flyback converter is used. When the current flowing through an inductor is stop, the energy stored within the magnetic flux is released by a sudden reversal of the terminal voltage. If a diode is in situ to conduct the stored energy somewhere useful, the diode is named a fly-back diode. This only requires one winding on the inductor, therefore the inductor would be called a flyback transformer. This arrangement has the interesting property of transferring energy to the secondary side of the facility supply only the first switch is off. The basic flyback converter uses a comparatively small number of components. A switching device chops the input DC voltage and therefore the energy within the primary is transferred to the secondary through the switching transformer. A diode within the secondary rectifies the voltage while the capacitor smoothes the rectified voltage. A three-phase inverter working rule is, it includes three inverter switches with a single-phase where each switch is often connected to a load terminal. This waveform includes a zero voltage stage among the 2 sections like positive &negative of the square wave. An inverter takes the DC output voltage of the renewable energy system or backup batteries and converts it to AC. In small-scale user systems, the output is usually a typical utility voltage and maybe a single-phase output voltage or a three-phase voltage, counting on the system. This AC output of the inverter is given to the grid as input. The power stored in the battery is used for electrical cars. Sometimes energy generated from renewable sources is insufficient for electrical cars. At that time grid can provide power to the EV's. The power generated from the solar panels is given to the grid also.

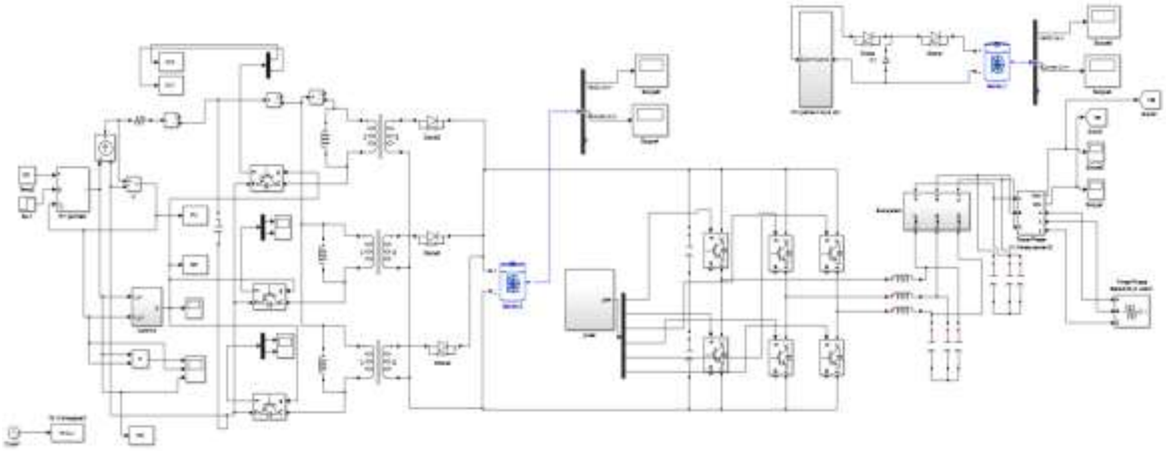


FIG.[4] Matlab simulation for three port EV-PV converter

Performance Measures

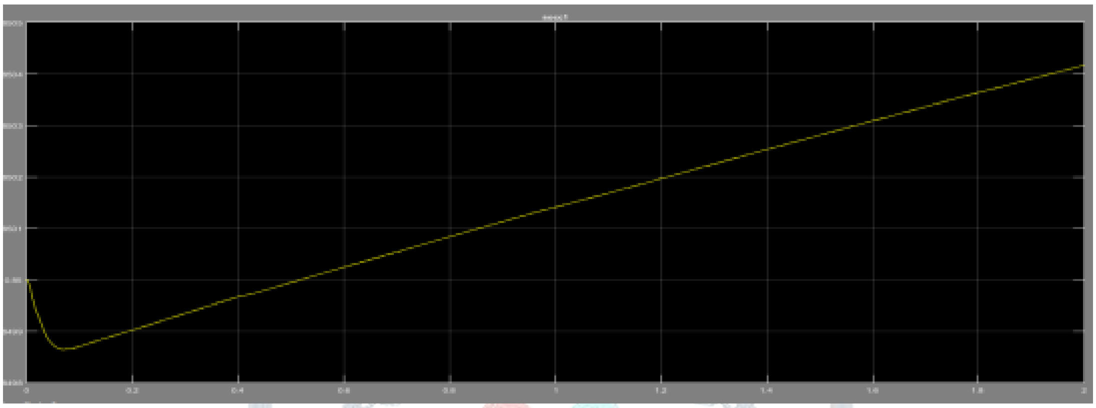


FIG.[5] SOC of the battery

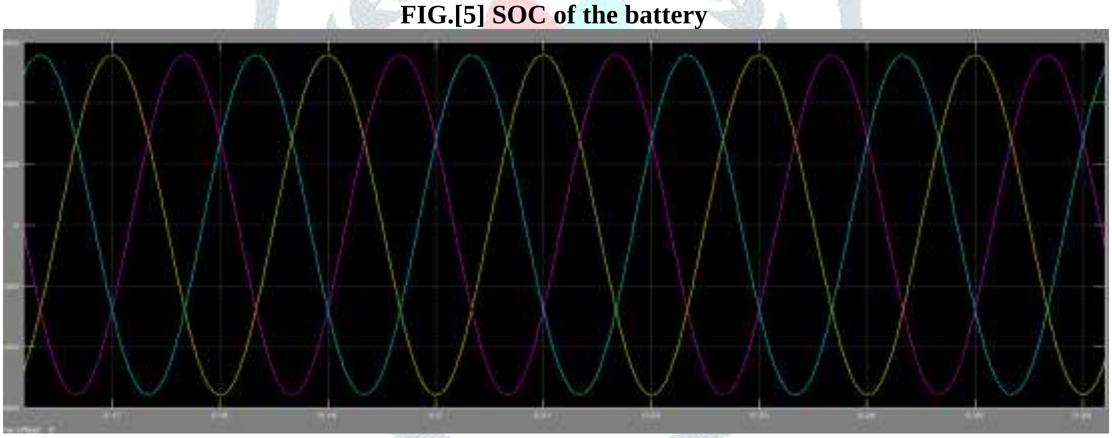


FIG.[6] Inverter Voltage Output

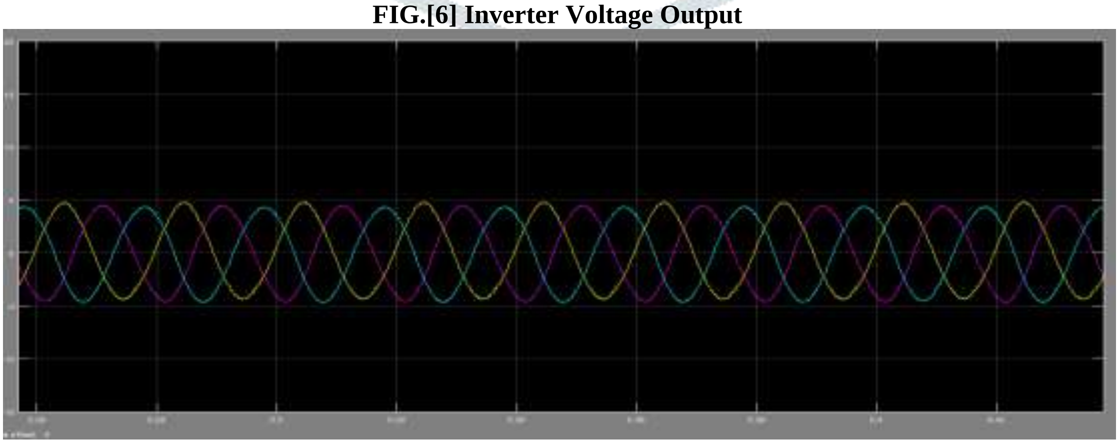


FIG.[7]Inverter Current Output

III. Second Topology: V2G dynamic regulation model with wind

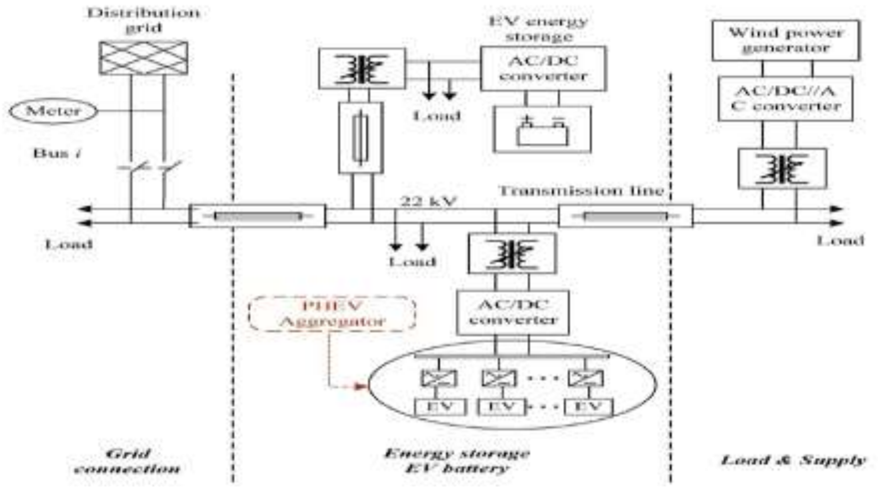


FIG.[8] Block Diagram of V2G dynamic model with wind and solar

As shown in above fig.8, the wind power generator, EVs, and other loads are clustered at a certain bus in the test distribution grid. As EVs are employed to locally catch up on the facility fluctuation caused by neighboring renewable resources, the general power flow of the cluster is often smoothed, thus eliminating the negative effect on the power quality of the external grid. The experimental setup utilizes the control signal produced by simulation software where the load profile, wind generation fluctuation, and corresponding instructions for V2G power are calculated. A downscaled experimental setup is made to implement the simulation algorithm. Three types of components are electrically connected in the network: the load, the resource, and the battery energy storage. In this case, the electronic load and regulated power supply are used to emulate the load and the varying wind power generation. These components are tied to an internal 380-Vdclink and connected to the external ac grid through a dc/ac converter. The converter controller is meant to take care of the dc-link voltage and regulate the output voltage for every component. Fig. shows the dynamic power regulation of the battery storage in response to the varying load and supply. The instantaneous changes in the power supply are measured. The battery is charged to soak up the excessive power supply and is discharged when the demand becomes larger. The power response of the EV battery is captured to demonstrate its capability of reacting appropriately to the wind generation fluctuation in real-time. The power flow at the connecting point during the transition period is presented in this system. It can be observed that the ac injected into the 220-V electrical power network is distorted due to the abrupt changes of the wind power generation. In contrast, the available EV battery is activated to compensate for an equivalent change within the power network. The ac power flow is often stabilized when the battery storage is deployed for dynamic power compensation.

i) Simulation for second topology:

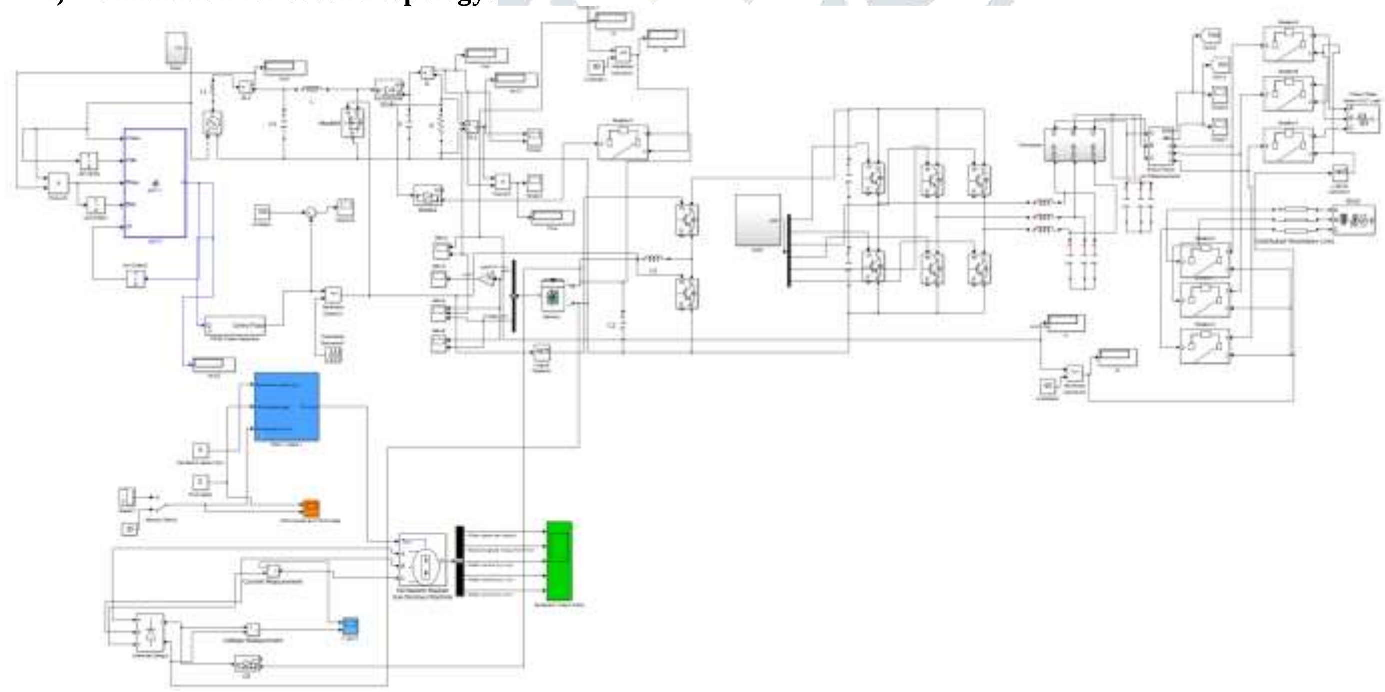


FIG.[9] Matlab simulation for V2G dynamic regulation mode

For the hybrid power generation, both wind turbine and solar panels are simulated in one simulation with the grid and storage of power in the battery. V2G power is regulated to attenuate the entire operating expense (TOC) while providing frequency regulation. The simulation results verify the control algorithm in coordinating distributed electric vehicle (EV) aggregations with the varying wind generation and daily load. Wind power or wind energy is that the use of wind to supply mechanical power

through wind turbines to show electric generators for electric power. Wind power may be a popular sustainable, renewable energy source that features a much smaller impact on the environment compared to burning fossil fuels. Wind farms contain many individual wind turbines, which are connected to the electrical power transmission network. Onshore wind may be a cheap source of electric power, competitive with, or in many places cheaper than, coal or gas plants. Onshore wind farms have a greater visual impact on the landscape than other power stations, as they have to be cover more land and wish to be built in rural areas, which may cause industrialization of the countryside and habitat loss. Offshore wind is steadier and stronger than ashore and offshore farms have less visual impact, but construction and maintenance costs are significantly higher. As shown in fig9.The power generated from both solar and wind renewable. In this simulation set point is set as 90. If the SOC is below 90 then the battery is charged from the solar and wind generators. And if the SOC is above 90 then, the battery is discharged to the grid.
Energy storage devices are required within the power system with large penetration of intermittent renewable energy sources. The widespread EVs within the power system has good prospects of acting as distributed energy storage thanks to the sufficient power capacity from an outsized number of EV onboard batteries and therefore the flexible power control provided by modern power electronic chargers.

Performance Measures:

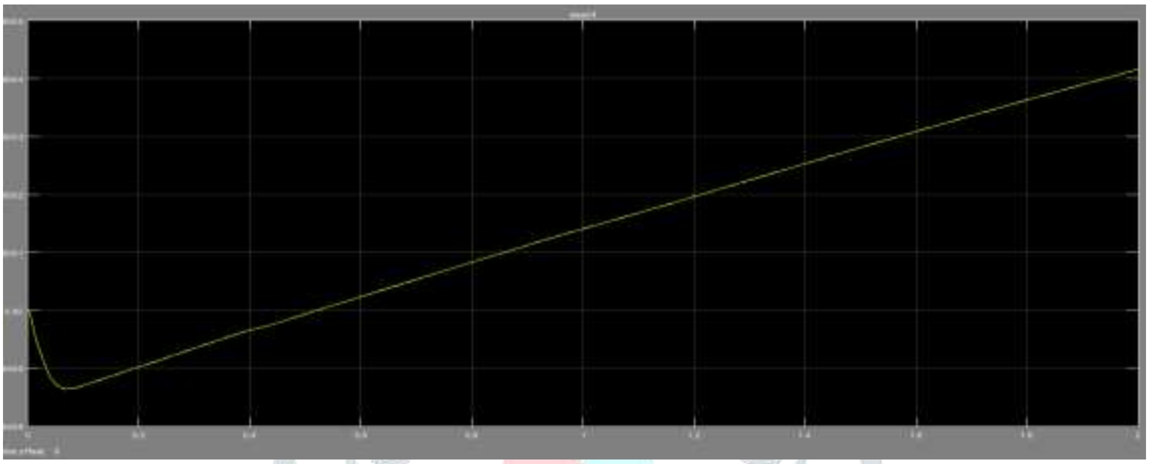


FIG.[10] SOC of battery in charging mode

As shown in above fig.6 the battery is charged from solar and wind renewable. The SOC charges above 90%.We consider the initial state of battery charging is 90%. So the battery is charged from both sources above 90%. And if the battery is already charged then the power is given back to the grid.

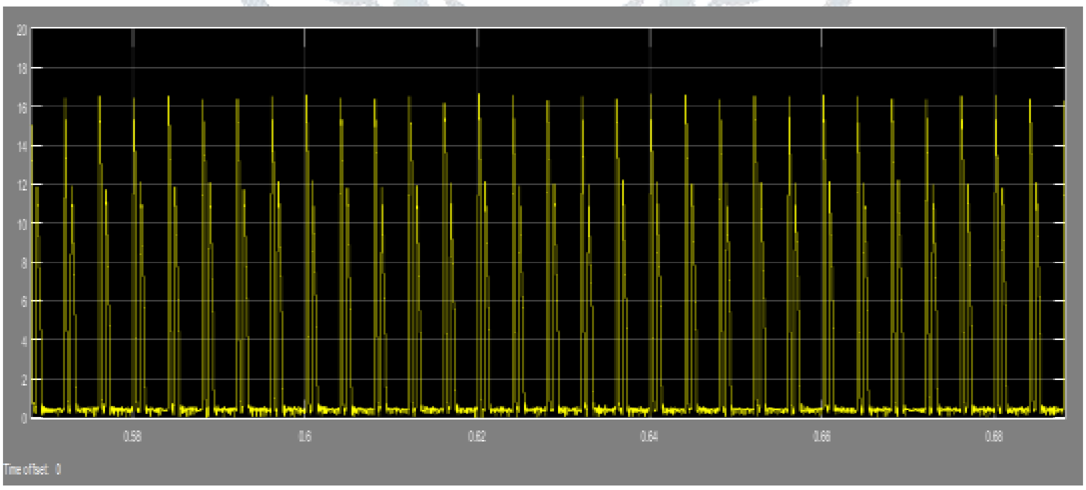


FIG.[11] State of charging current

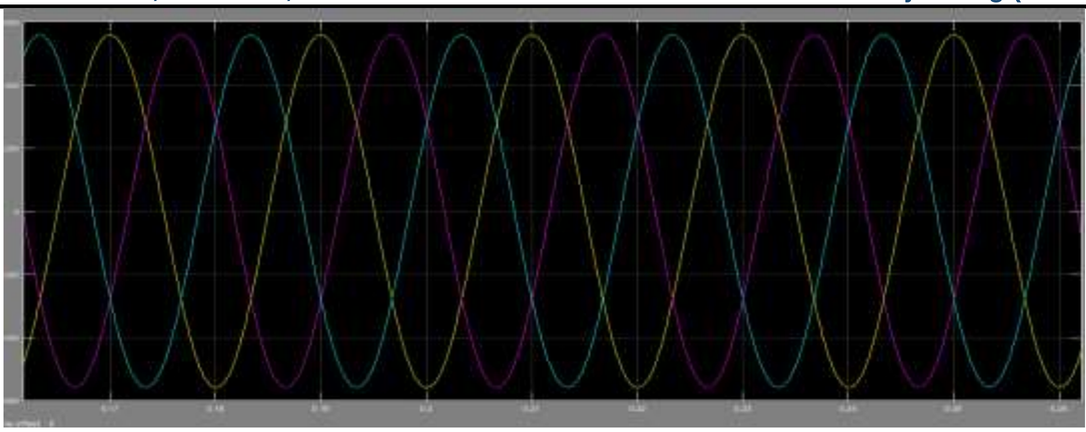


FIG.[12] Three phase inverter voltage output

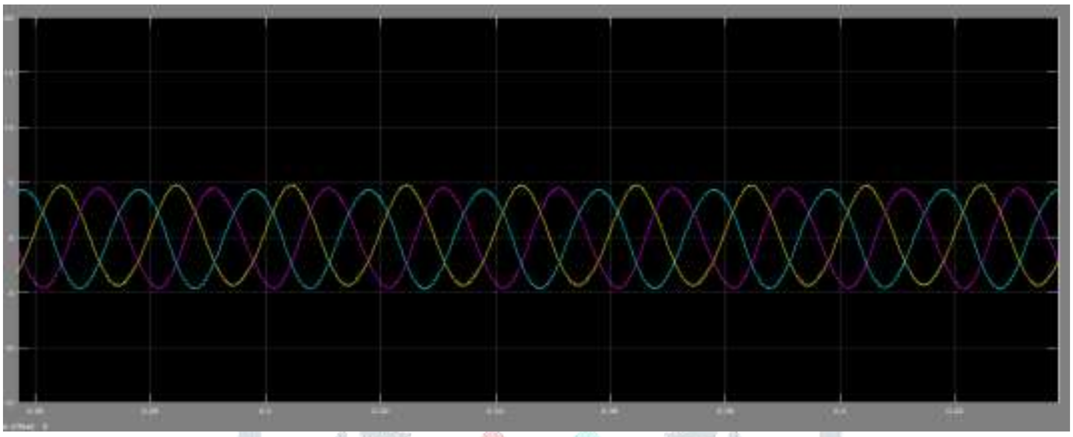


FIG.[13] Three phase inverter current output

IV. Results and Discussion:

This paper presents the three-port EV-PV converter and V2G dynamic regulation model. In a three-port EV-PV converter, a zeta converter is used and in the V2G model beta converter is used. The zeta converter has advantages over the other converter in that it has a wider range of duty ratio. Also, this converter has improved power factor, low input current distortion, low output current ripple, and wide output-power range. Finally, the concept of the three-port EV-PV converter with zeta converter has been verified by the simulation and results.

V. Acknowledgment:

I would like to offer my special thanks to all my friends, family, and teachers for motivating me and guiding me throughout this work journey. I would like to extend my appreciation to all who directly or indirectly help me in the completion of this work.

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