

Comparison of Charging Requirement for Batteries of Electric Vehicle Using Hybrid Converter

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ABSTRACT: To replace a dc/dc boost converter and a dc/ac converter to reduce conversion stages and switching loss Hybrid boost converter (HBC) has been proposed in this paper. The system is designed and tested by using three-phase HBC in a PV charging station. This HBC interfaces a PV system, a dc system with a hybrid plug-in electrical vehicles (HPEVs) and a three-phase ac grid. To realize maximum power point tracking (MPPT) for PV, dc bus voltage regulation, and ac voltage or reactive power regulation, the control of HBC is been designed.

KEYWORDS: Grid-connected Photovoltaic (PV), Hybrid boost converter (HBC), Plug-in hybrid vehicle (PHEV), Maximum Power Point Tracking (MPPT).

I. INTRODUCTION

The electric vehicle market is now growing very rapidly. According to the Ministry of Science, Industry and Technology of Turkey, on the road soon in Turkey PHEV will become the dominant vehicle choice. The increasing of PHEVs could burden the prevailing utility, which may result power losses at the purchasers end. Pakistan under Rahmat Group Company has signed an agreement with two different Chinese companies to introduce EVs in Pakistan. In the initial stage, the companies will introduce electric buses in the transport market, and in the second phase, a factory would be established at the complex in Jamshoro District of Sindh, Pakistan to produce electric cars and two-wheelers. According to the Energy Conservation Center belonging to the Ministry of Water and Power of Pakistan, the transport sector represents 28% of the total energy consumption in Pakistan within the Pakistan scenario reported on 30 June 2015, the gap between electricity demand and supply was 5201 MW. Currently, Pakistan is affected by severe energy crisis, where urban and rural areas aren't powered by proper electricity for 8–12 h and 18 h per day, respectively. There is a growing risk that the proliferation of EVs will trigger extreme surges in demand in Pakistan. This cannot be ignored, especially in Pakistan, and therefore, it is imperative to design a Charging Station (CS) setup powered from Renewable Energy Sources (RESs) including smart charging strategies.

The environmental and economic advantages of PHEV lead to the increase in number of production and consumption. The U.S. Department of Energy forecasts that over one million PHEVs will be sold in the U.S. during the next decade. The comparison of different PHEV chargers' topologies and techniques are reviewed in. Therefore, charging stations with PV as a further power source become a feasible solution. The charging management is developed in by considering the grid's loading limit. For this sort of systems, it requires controlling a minimum of three different power electronic converters to charge PHEVs. Each converter needs a private controller, which increases complexity and power losses of the system. Consequently, it is urgent to investigate multi-port converters to reduce the number of converting stages [3].

The ongoing research in the field of plug-in hybrid electric vehicles (PHEVs) and the growing global awareness for a pollution free environment will lead to an increase in the number of PHEVs in the near future [4]. The proliferation of these PHEVs will add stress to the already overloaded U.S grid creating new challenges for the distribution network. Though it is always advantageous to charge the EV's during night time there will be considerable PHEV load during the day and even during the hours of peak demand. Transmission and distribution systems are often upgraded to satisfy the height demand but this might end in capacity surplus during normal operating conditions. There is also a potential risk of night- charging challenge as the TOU (time-of-use) pricing is designed to discourage charging during the daytime. The objective of the paper is to implement such a multi-port converter during a PV charging station for PHEVs and style the controller.

II. RELATED WORK

A three-phase HBC uses the same amount of switches as a two-level voltage source converter (VSC). However, the HBC can realize both dc/dc conversion and dc/ac conversion. As a comparison, Fig shows the conventional PV charging station where a dc/dc boost converter and a three-phase VSC are used to integrate the PV system, the PHEVs and the ac grid. A three phase HBC replaces the two converters: the dc/dc boost converter and the dc/ac three-phase VSC to decrease the energy conversion stages and the power losses of the PV charging station. Fig. 2 shows the HBC-based PV charging station's topology. The main components of the configuration of the PV charging station consist of PV array, three-phase bidirectional HBC, ac grid, off-board dc/dc converter, and PHEV's batteries. There are two Charging Station diagram one is Configurations of a CS Diagram and another is Architecture Diagram.

2.1 Configurations of a CS Diagram

The following Fig. 1 diagram shows the Configurations of a CS Diagram it consist of grid, dc/dc converter consist of DC bus, voltage source converter and PHEV's. The system is charged by directly grid by using

converters. There are no any other source of power is here.

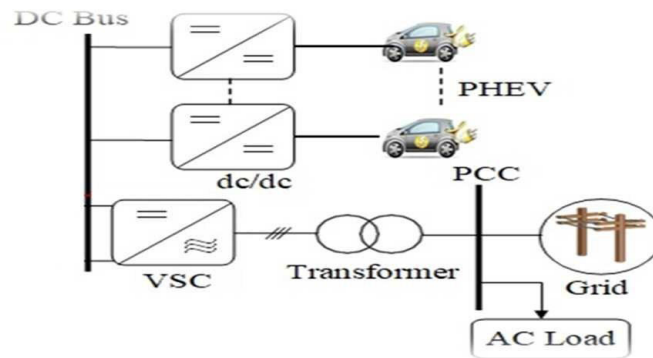


Fig. 1 Present configurations of a charging station

There are two converters are required for the total system operation. There are no back-up system is required for PHEVs charging [1].

2.2 Architecture Diagram

The following diagram shows the Configurations of a CS Diagram it consist of Solar System, dc/dc boost converter, Three phase hybrid converter, Grid, dc/dc converter consist of DC bus, voltage source converter and PHEV's. There are the charging station control is done by two power source one is solar power system and another is Grid [7].

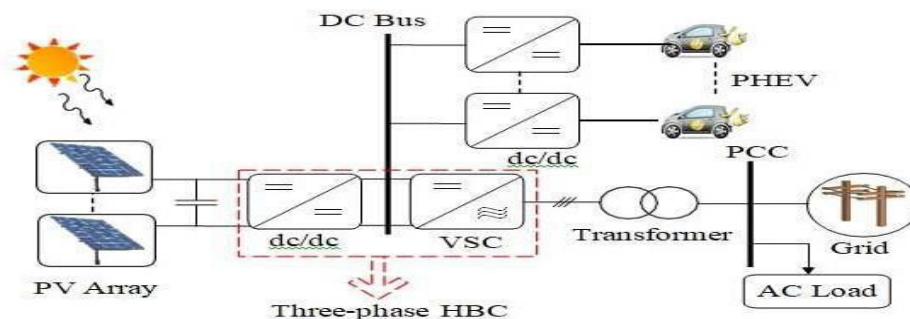


Fig. 2 Architecture configurations of a PV charging station. The conventional topology includes a dc/dc converter and a dc/ac VSC. These two converters will be replaced by a three-phase HBC.

Three phase HBC uses the same amount of switches as a two-level voltage source converter (VSC). However, the HBC can realize both dc/dc conversion and dc/ac conversion. As a comparison, Fig. 2 shows the conventional PV charging station where a dc/dc boost converter and a three-phase VSC are used to integrate the PV system, the PHEVs and the ac grid. A three-phase HBC replaces the two converters: the dc/dc boost converter and the dc/ac three-phase VSC to decrease the energy conversion stages and the power losses of the PV charging station. Fig. 3 shows the HBC-based PV charging station's topology. The main components of the configuration of the PV charging station consist of PV array, three-phase bidirectional HBC, ac grid, off-board dc/dc converter, and PHEV's batteries. In order to design the control of a PV charging station, it is essential to understand the operation of a three-phase HBC. The system is composed of a PV array; a dc system, a three phase ac system, and the interfacing three phase HBC as shown in Following fig. The PV side includes a large inductance to achieve continuous condition and capacitance to decrease the voltage ripple. The dc side includes a diode, a dc bus for PHEV connection, a dc capacitor to eliminate the output current ripples, an off-board unidirectional isolated dc/dc converter, and PHEV batteries. The ac system includes a three-phase LC filter, a step up transformer, and the point of common coupling (PCC) bus that connects the PV station to the main grid [6] [1].

III. METHODOLOGY

The main components of the configuration of the PV charging station consist of PV array, Three-phase bidirectional HBC, AC grid, Off-board dc/dc converter, and PHEV's batteries.

3.1 AC grid: -

An electrical grid, electric grid or power grid is an interconnected network for delivering electricity from producers to consumers. It consists of Generating stations that produce electric power, Electrical substations for stepping electrical voltage up for transmission, or down for distribution, High voltage transmission lines that carry power from distant sources to demand-centers, Distribution lines that connect individual customers. Electrical grids vary in size from covering a single building through national grids (which cover whole countries) to transnational grids (which can cross continents). Power stations connected to grids are often located near energy resources such as a source of fuel or to take advantage of renewable energy resources, and away from heavily-populated areas.

A bulk-power transmission network is therefore used to move the power long distances, sometimes across international boundaries, until it reaches its wholesale customer (usually the organization that owns the local electric power distribution network). The electric power is therefore stepped up to a high voltage for the electric power transmission system. On arrival at a substation, the power will be stepped down from a transmission level voltage to a distribution-level voltage. As it exits the substation, it enters the distribution wiring. Finally, upon arrival at the service location, the power is stepped down again from the distribution voltage to the required service voltage(s). Electrical grids can be prone to malicious intrusion or attack; thus, there is a need for electric grid security. Also as electric grids modernize and introduce computers, cyber threats also start to become a security risk. Particular concerns relate to the more complex computer systems needed to manage grids.

3.2 PV array:-

A photovoltaic system, also PV system or solar power system is a power system designed to supply usable solar power by means of photovoltaic. It consists of an arrangement of several components, including solar panels to absorb and convert sunlight into electricity, a solar inverter to convert the output from direct to alternating current, as well as mounting, cabling, and other electrical accessories to set up a working system. It may also use a solar tracking system to improve the system's overall performance and include an integrated battery solution, as prices for storage devices are expected to decline. Strictly speaking, a solar array only encompasses the ensemble of solar panels, the visible part of the PV system, and does not include all the other hardware, often summarized as balance of system (BOS). As PV systems convert light directly into electricity, they are not to be confused with other solar technologies, such as concentrated solar power or solar thermal, used for heating and cooling.

3.3 DC to DC Converters

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). The different configurations of EV power supply show that at least one DC/DC converter is necessary to interface the FC, the Battery or the Super capacitors module to the DC-link. In electric engineering, a DC to DC converter is a category of power converters and it is an electric circuit which converts a source of direct current (DC) from one voltage level to another, by storing the input energy temporarily and then releasing that energy to the output at a different voltage. The storage may be in either magnetic fieldstorage components (inductors, transformers) or electric field storage components (capacitors). DC/DC converters can be designed to transfer power in only one direction, from the input to the output. However, almost all DC/DC converter topologies can be made bi-directional. A bi-directional converter can move power in either direction, which is useful in applications requiring regenerative braking. The amount of power flow between the input and the output can be controlled by adjusting the duty cycle (ratio of on/off time of the switch). Usually, this is done to control the output voltage, the input current, the output current, or to maintain a constant power. DC/DC converters can be grouped as follows:

3.3.1 Non-isolated converters

The non-isolated converters type is generally used where the voltage needs to be stepped up or down by a relatively small ratio (less than 4:1). And when there is no problem with the output and input having no dielectric isolation. There are five main types of converter in this non- isolated group, usually called the buck, boost, buck-boost, Cuk and charge-pump converters. The buck converter is used for voltage step-down, while the boost converter is used for voltage step-up. The buck-boost and Cuk converters can be used for either step-down or step-up. The charge-pump converter is used for either voltage step-up or voltage inversion, but only in relatively low power applications [3] [4].

3.3.2 Isolated converters

Usually, in this type of converters a high frequency transformer is used. In the applications where the output needs to be completely isolated from the input, an isolated converter is necessary. There are many types of converters in this group such as Half-Bridge, Full-Bridge, Fly-back, Forward and Push-Pull [3] [4].

3.4 PHEV's:-

A plug-in hybrid electric vehicle (PHEV) is a hybrid electric vehicle whose battery can be recharged by plugging it into an external source of electric power, as well as by its on-board engine and generator Plug-in hybrids, also known as plug-in hybrid electric vehicles or PHEVs, generally have a larger and more powerful battery than their non-plug-in hybrid counterparts, enabling them to operate entirely on electrical power like a purely electric vehicle that has no gas engine.

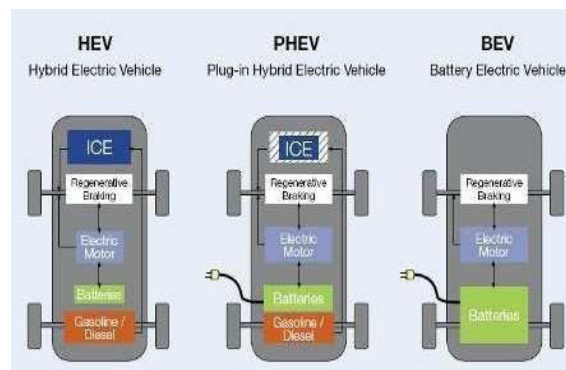


Fig. 3 Types of Electric Vehicles

The reason that hybrid vehicles are more efficient than conventional gasoline-only vehicles is because they have the ability to "reclaim" energy that was once wasted, for example, the energy used when braking. All hybrid cars carry a battery pack in order to store electricity for their electric motor. A plug-in hybrid electric vehicle (PHEV) is a hybrid electric vehicle whose battery can be recharged by plugging it into an external source of electric power, as well as by its

on-board engine and generator. Most PHEVs are passenger cars, but there are also PHEV versions of commercial vehicles and vans, utility trucks, buses, trains, motorcycles, scooters, and military vehicles. Similarly to all-electric vehicles, plug-in hybrids displace emissions from the car tailpipe to the generators powering the electricity grid [10] [11] [08]. These generators may be renewable, or may have lower emission than an internal combustion engine. Charging the battery from the grid can cost less than using the on-board engine, helping to reduce operating cost. Plug-in hybrid operates in charge-depleting and charge-sustaining modes. Combinations of these two modes are termed blended mode or mixed-mode. These vehicles can be designed to drive for an extended range in all-electric mode, either at low speeds only or at all speeds. These modes manage the vehicle's battery discharge strategy, and their use has a direct effect on the size and type of battery required: Charge-depleting mode allows a fully charged PHEV to operate exclusively (or depending on the vehicle, almost exclusively, except during hard acceleration) on electric power until its battery state of charge is depleted to a predetermined level, at which time the vehicle's internal combustion engine or fuel cell will be engaged. For example, a car may begin a trip in low speed charge-depleting mode, then enter onto a freeway and operate in blended mode. The driver might exit the freeway and drive without the internal combustion engine until all-electric range is exhausted. The vehicle can revert to a charge sustaining-mode until the final destination is reached. This contrasts with a charge-depleting trip which would be driven within the limits of a PHEV's all-electric range [10] [11].

IV. EXPERIMENTAL RESULTS

- 1 HP Model:

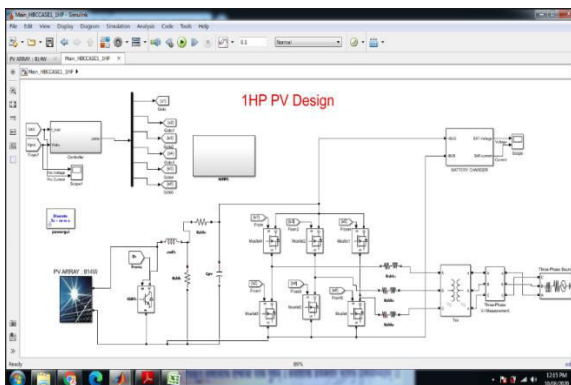


Fig 4: 1 HP Model

- 2 HP Model:

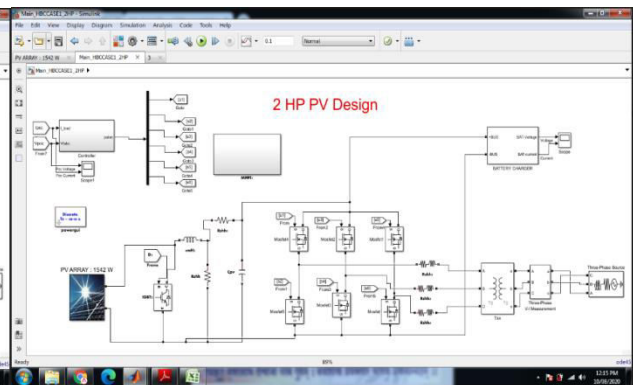


Fig 5: 2 HP Model

- 2HP THD:

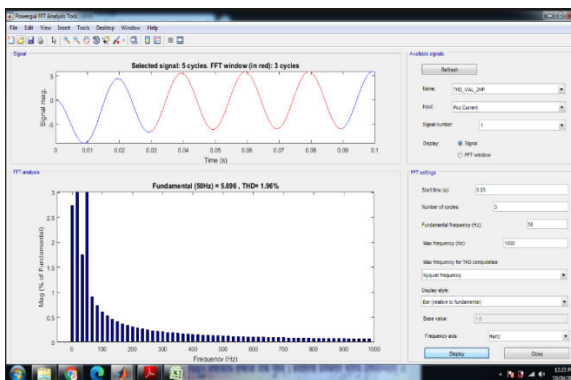


Fig 6 : 2 HP THD

- 1HP THD:

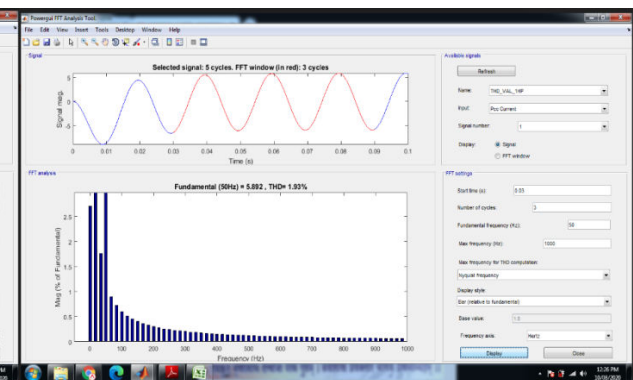


Fig 7 : 2 HP THD

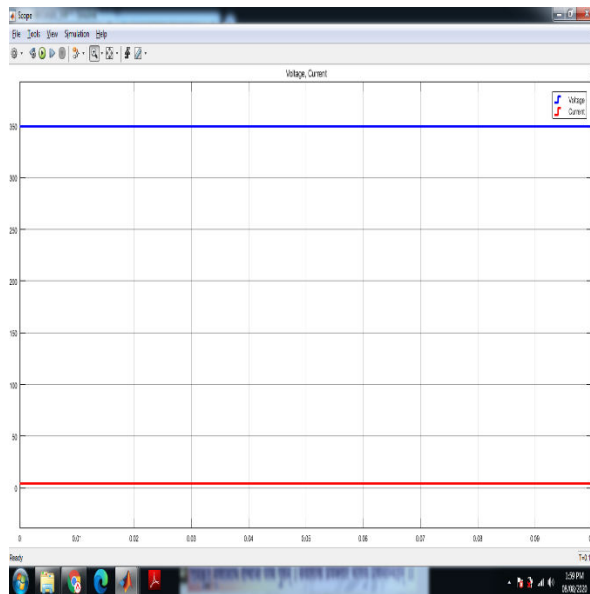
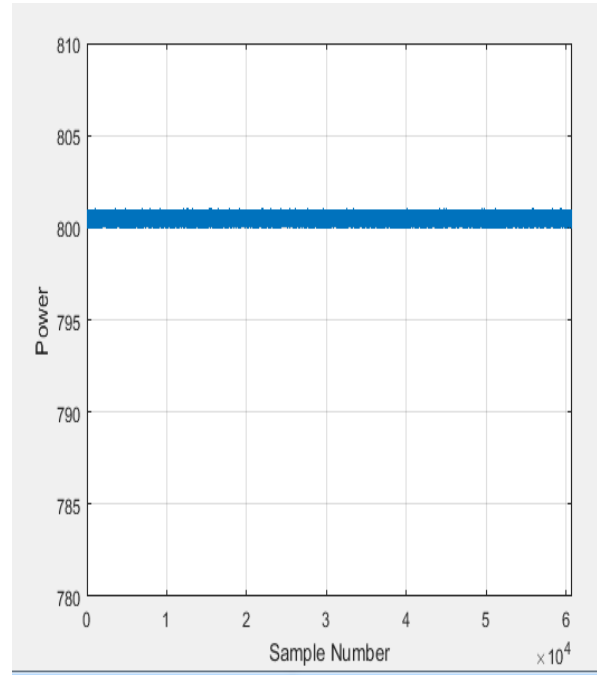
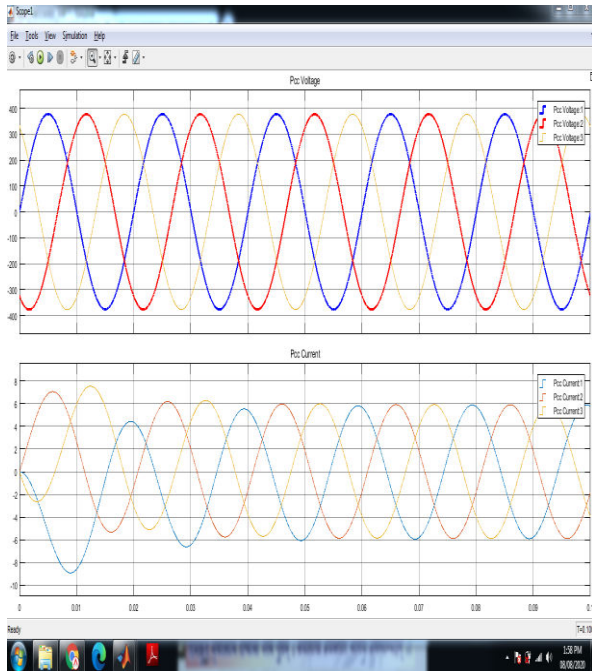


Fig 8 :- 1KW Outputs

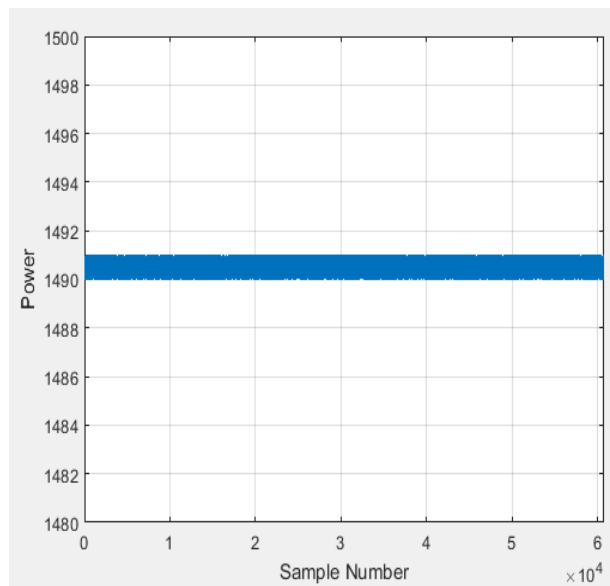
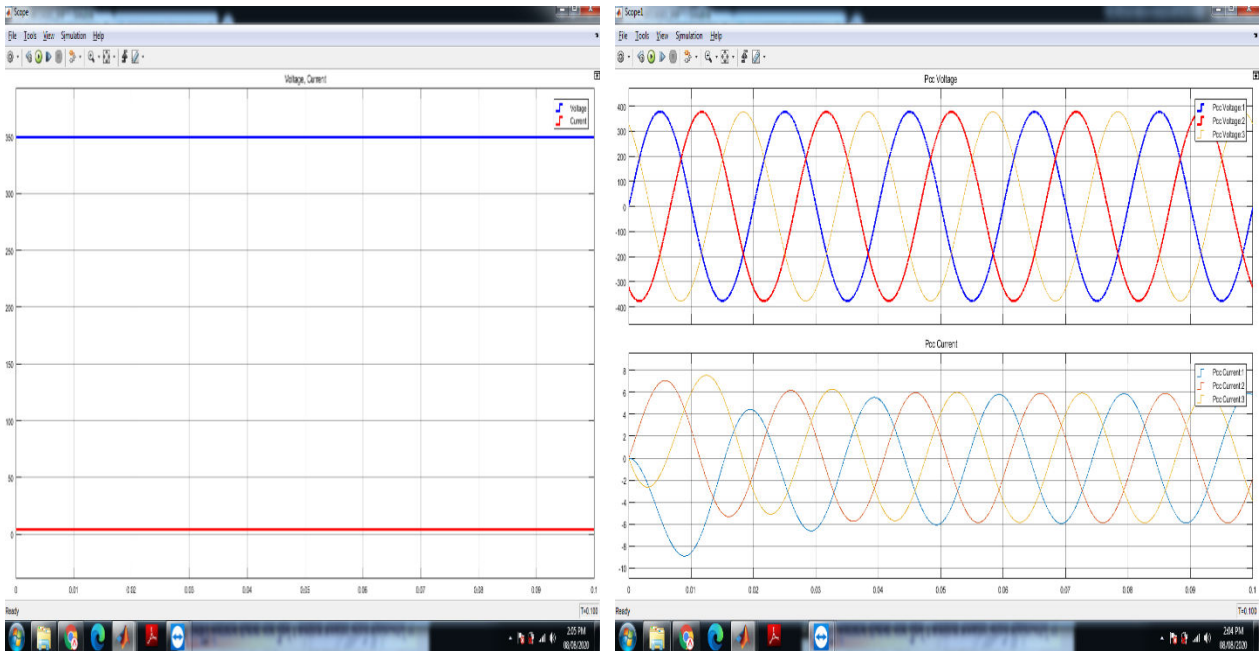


Fig: - 2HP outputs

V. CONCLUSION

This paper proposes Comparison of Charging Requirement for Batteries of Electric Vehicle Using Hybrid Converter. Without proper management, the penetration of PHEVs in the transportation sector can cause a burden on the distribution systems, especially when many PHEVs are connected to the grid at peak-hours. To face this concern, the distribution system requires to be improved to carry new loads. By doing the literature it seems to be demand increases in future on grid and this project helps to balance the demand response as well as helps for battery management system of PHEVs. The project helps to supply continuous dc power to electric vehicles.

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