



PERFORMANCE ANALYSIS OF ELECTRIC VEHICLE WITH BATTERY AND SOLAR PV SOURCES

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Abstract: Electric vehicles (EVs) are becoming more and more popular worldwide as a way to avoid harmful pollutants and cut down on the use of petroleum goods. However, due to certain disadvantages of EVs, such as the lack of charging stations on the highway, battery overheating during extended travel, and insufficient starting torque, especially when riding uphill, or acceleration after a break is applied, people are reluctant to purchase and use EVs. Several renewable sources can be used to increase the efficiency of electric vehicles. Additionally, this will increase the vehicle's range (run time). Additionally, the numerous sources will improve the beginning torque, which is a common issue with electric vehicles. As a result, fewer refueling stops are required on the roadways. Thus, the primary issue with electric vehicles is their lower long-term reliability and the requirement for refueling stations along highways. More initial funding is required, which developing and underdeveloped nations cannot provide. With the suggested system, this issue is now resolved. Battery and solar photovoltaic sources were used as the electric vehicle's inputs in the suggested system. For a long time, the energy

generated by the solar panel throughout the day may now be stored in the battery and used whenever needed. Another potential source that is not covered by the suggested system is a fuel cell. MATLAB Simulink is used to analyze the output voltage and power of the suggested battery-solar PV hybrid system.

KEY WORDS: Electric vehicle, Battery, Solar PV, Hybrid Vehicle, BLDC Motor, VSI, Controller.

1. INTRODUCTION

The quest for renewable energy sources is currently one of the biggest engineering challenges. Electricity production in a large portion of the world is heavily reliant on coal and natural gas. Despite its abundance, this power source has been proved to contribute to global warming. Additionally, it has been demonstrated that extraction techniques like hydraulic fracturing have a negative impact on the environment, specifically causing earthquakes. Solar energy is one energy source that is being thoroughly researched. Prior to recently, solar energy could not be a practical substitute for fossil fuel-based energy because of the low efficiency of solar panels.

Solar energy is being used as a renewable resource to gradually meet society's accustomed energy demands thanks to advancements in materials science. In 2014, transportation was responsible for 26% of all greenhouse gas emissions, according to the EPA [01–05]. The idea of a solar car will be developed and constructed for this project. Since vehicles have previously been converted to use alternative fuels, an urban application solar car will be created for this project in accordance with the guidelines for the Shell Ecomarathon Urban Concept Battery Electric competition. The construction of an electric car that can generate power utilizing solar energy technology is the main goal of the project. This kind of vehicle would significantly reduce the need for gasoline if it were made a typical commercial vehicle. The main challenge was making this vehicle practical. The vehicle must be light in order to reduce the size of the motor needed to meet the demands of urban transportation. Practically speaking, more room would be required for more passengers and cargo because the vehicle is only intended to accommodate one driver [06-08].

The solar panel's efficiency in producing enough power for propulsion in an acceptable amount of time is another factor to take into account when using solar energy to power a car. This results in a number of choices that need to be made throughout the design phase. The project requires consideration of both mechanical and electrical engineering factors. The components must be appropriate for the Shell Eco-marathon's urban concept division. To fit

the application, components will be bought and made from raw materials. Because of the vehicle's unusual size, several parts will need to be machined according to standards. Financial limitations and the viability of manufacture will be taken into consideration while making decisions [09-12].

All-electric vehicles (EVs) run on electricity only. They are propelled by one or more electric motors powered by rechargeable battery packs. EVs have several advantages over conventional vehicles:

1.1 Various Benefits of EV

Energy efficient. EVs convert over 77% of electrical energy from the grid to power at the wheels. Conventional gasoline vehicles only convert about 12% to 30% of the energy stored in gasoline to power at the wheels.

Environmentally friendly. EVs emit no tailpipe pollutants, although the power plant producing the electricity may emit them. Electricity from nuclear-, hydro-, solar-, or wind-powered plants causes no air pollutants.

Performance benefits. Electric motors provide quiet, smooth operation and stronger acceleration and require less maintenance than internal combustion engines (ICEs).

Reduced energy dependence. Electricity is a domestic energy source.

Driving range. EVs have a shorter driving range than most conventional vehicles—although EV driving ranges are improving. Most EVs can travel more than 100 miles on a charge, and some can travel in excess of 200 or 300 miles depending on the model.

Recharge time. Fully recharging the battery pack can take 3 to 12 hours. Even a "fast charge" to 80% capacity can take 30 min [13 – 14].

1.2 Performance of Batteries

When solar energy is produced during the day, the battery stores it for use at night or in situations when the solar panels are not producing electricity. Depending on the sun, the solar module will either charge or deplete the battery. The voltage of each accumulator cell is 2 volts, which is within international requirements. Thus, a 12-volt battery contains six cells, whereas a 24-volt battery contains twelve cells. Several low voltage or power batteries connected in series or parallel, depending on the power requirements, make up the battery storage system. When the electrical state of the chemical reaction falls below the designated terminal level, the battery charges, and when the energy is fully charged, it discharges electrical energy. The following formula can be used to calculate the necessary battery capacity: Daily Energy = Battery Capacity Voltage of the Battery (3) Depending on the type of battery being

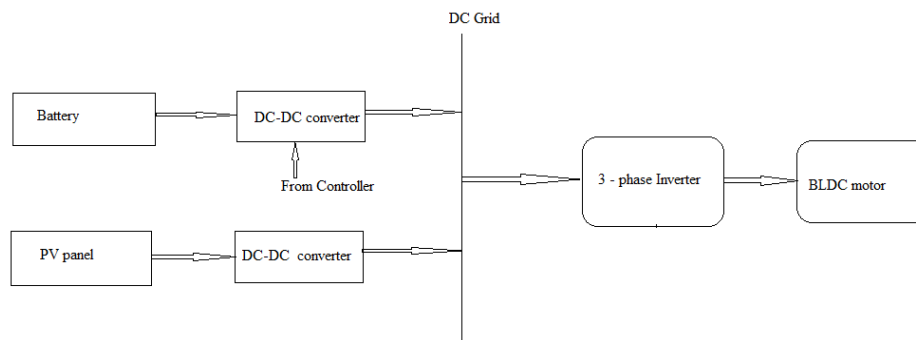
used, the depth of discharge and losses are taken into account when calculating battery capacity.

2. PROPOSED SYSTEM

To support the faces of various components and the ability to estimate its inclusive performance in a responsive simulation environment, a self-driven simulation model for a solar PV-based vehicle is developed using MATLAB/SIMULINK. This project's primary goal is to use MATLAB/SIMULINK to model the operation of an electric car powered by solar photovoltaics. The PMBLDC motor, battery, and PV panel are crucial parts. The vehicle's performance is examined and its key parts are modeled. This type uses an IGBT-based Buck-Boost converter that raises the output voltage to the desired level in order to charge the battery. Furthermore, a voltage source inverter that uses Hall sensors to operate in a closed loop is intended to power the BLDC motor. As a result, this model's simulation results are examined.

A solar PV cell is a device that uses the photovoltaic effect to directly convert solar energy into electrical energy. When exposed to light, it changes electrical properties like voltage and current. Figure 1 depicts the solar cell equivalent circuit, which explains the current extracted from the solar cell..

2.1 BLOCK DIAGRAM



3. Fig 2 Block Diagram

Two renewable energy sources make up the suggested hybrid electric system: a battery and a solar panel. To maintain a steady dc voltage, both sources are linked to the bus or dc grid. The voltage is then supplied to a three-phase voltage source inverter. The VSI runs a BLDC motor by converting the supplied dc to ac. The three-phase VSI was tuned by the PI controller by timing the gate signal. Figure 2 shows the block diagram for the suggested system.

Hybrid systems are typically utilized to extend the electric vehicle's range and eliminate the need for an internal combustion engine. In this approach, pollution from fossil fuels like gasoline and diesel can be decreased. Additionally, it lessens the need for refueling stations, which are extremely difficult to build on steep roads. The public views electric vehicles as more reliable as a result.

2.2 CIRCUIT DIAGRAM

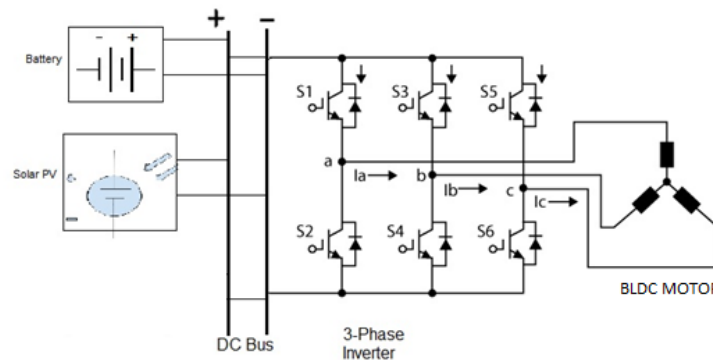


Fig 3 Circuit Diagram

Two sources of renewable energy The dc bus is powered by a battery and solar PV, and a three-phase inverter delivers the three-phase ac voltage to the BLDC motor. The controller receives the output voltage and current as feedback. The feedback signal allows the inverter to maintain a steady output voltage across the motor. The inverter receives the firing pulse from the PI controller. When it comes to adjusting the inverter to meet output requirements, PI controllers are incredibly efficient. Both the battery and the DC bus are powered by solar energy. The BLDC motor is powered by a three-phase voltage source inverter. As a result of the inverter's connection to the DC bus, the source voltage remains steady. As a result, connecting a capacitor is not necessary to maintain a steady input voltage. The three-phase inverter can effectively run the BLDC motor with a steady dc voltage from the dc bus. To adjust the firing pulse and maintain a steady output voltage across the motor, the voltage sensor senses changes in the voltage and relays that information to the controller. Figure 3 displays the proposed system's circuit diagram.

3. Simulation Diagram

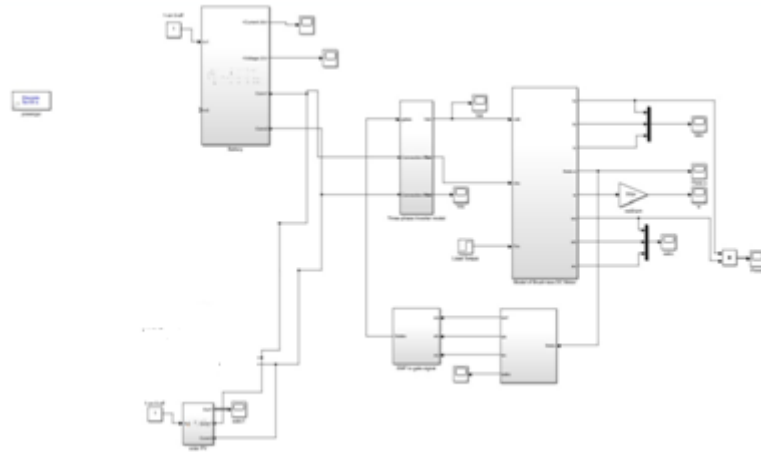


Fig 4 Simu-link diagram

The simulink diagram is shown in fig 4.

3.1 OUTPUT VOLTAGE WAVEFORM WITH BATTERY

The output voltage wave form with battery source alone is shown in figure 5.

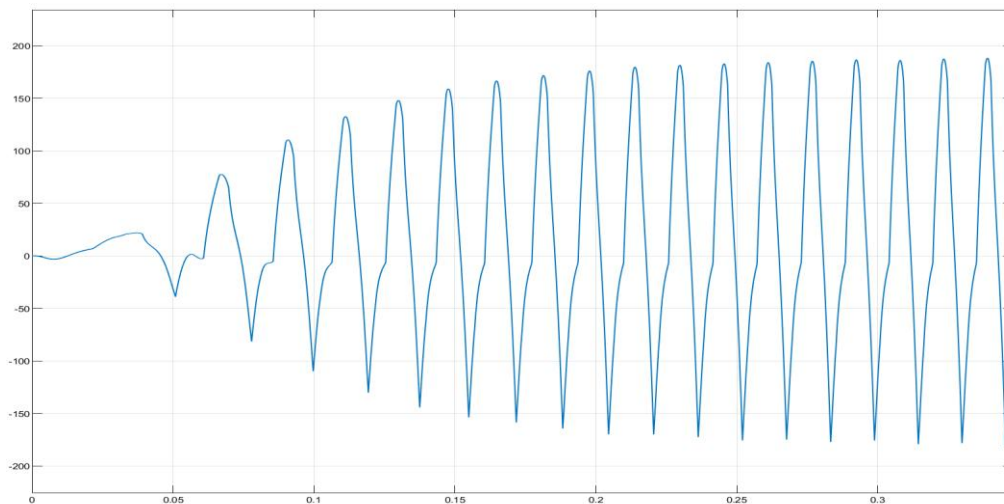


Fig 5 Output voltage waveform with battery

3.2 OUTPUT VOLTAGE WAVEFORM WITH BATTERY & SPV

The output voltage wave form with battery source and Solar PV is shown in figure 6.

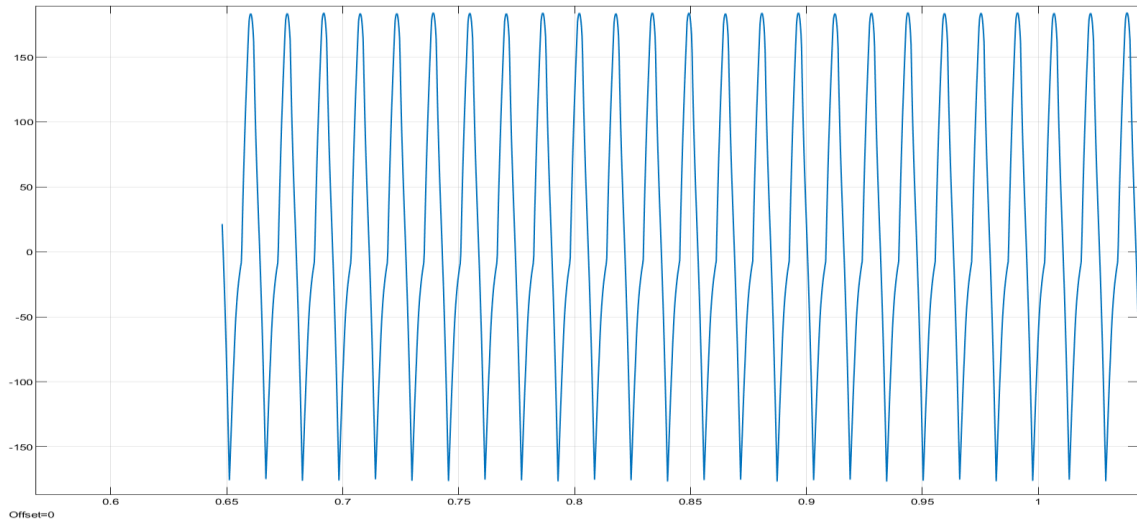


Fig 6 Output voltage waveform with battery & spv

5. CONCLUSION

More sources will significantly improve the electric vehicle's performance. The suggested solution includes a solar photovoltaic (SPV) source and a battery. Two sources are provided to the inverter in order to operate the BLDC motor and obtain a three-phase output. The purpose of the PI controller is to keep the motor's output steady even when the load varies. To keep the output voltage steady, a PPI controller is employed in conjunction with the feedback system. Several renewable sources can be used to increase the efficiency of electric vehicles. Additionally, this will extend the vehicle's range. The starting torque, a major issue with electric vehicles, will also be improved by the many sources. It lessens the requirement for a large number of highway refueling points. Therefore, the main issue with electric vehicles is their lower long-term reliability and the requirement for high-way refueling stations. It requires a larger initial investment, which developing and underdeveloped nations cannot afford. The suggested system now resolves this issue.

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