Journal of Science Engineering Technology and Management Science
Volume 02, Issue 01, January 2025
www.jsetms.com

BLDC Motor-Driven Electric Vehicle Design: Solar-Powered

Pravallika
Andhra University, Department of Electrical and Electronics Engineering, Bangalore
Corresponding Author: pravallikaeee@gmail.com

To Cite this Article
Pravallika, "BLDC Motor-Driven Electric Vehicle Design: Solar-Powered", Journal of Science Engineering Technology and Management Science, Vol. 02, Issue 01, January 2025, pp:09-14

Abstract*: Without power, any component is just a bunch of idle parts. This is especially so with those that rely on the non-renewable sources. We need to make a pro-active shift in our energy source from fossil fuels to renewable source. This paper describes the design of a Solar Powered BLDC Motor Driven Electric Vehicle which is one approach to tackle the upcoming crisis. In this work, the approach chosen for selection of suitable elements in this application is reviewed and each one are modelled simulated and tested through real time environment. The solar module, charge controllers, batteries therefore were integrated to the boost converter and BLDC motor made up the Solar Powered Electric Vehicle henceforth developed.*

Keywords*: Photovoltaic, renewable energy, solar vehicle, and BLDC motor*

I. Introduction

The solar energy can be used to run the car and this paper discusses about it. To get the required voltage they can be paralleled or connected in series, but it is costlier. So, in order to do it economically; inertia storage and batteries are been implemented. The PV panel integrates the electrical charge and sends it to output terminals, generating low voltage (Direct Current). This power gained from the solar panel is guided to the batteries by the charge controllers. The charging is done according to the state of the battery, so as to avoid over-charging or deep discharge. Then the voltage is uppered up by boost power converter finally driving the BLDC motor which acts as a drive one for our vehicle application. In past work (mail), the distinct property of elements; solar module, charge regulator, battery and power converter & BLDC motor required by car application was researched experimentally as well as was modelled independently in MATLAB/SIMULINK and entire hardware interfacing of arrangement is tried for satisfying necessity of use.

II. Getting Energy from the Sun

The initial section of this paper is in respect to the manner by which it can be discharged from sun and sustains charging in battery. The second part concerns with the consumption of this energy in operating and controlling the motor, while simultaneously charging the battery. The rating of the parts needed of this work is entirely based on the motor which has to be carried out the appliance. For our application, we are using the 400Watts (24V, 8.5A) BLDC motor. The motor's rating determines the selection of other hardware parts. We now require four 6V/21Ah batteries in line to run the BLDC motor, which raises the anticipated cost of the vehicle design. The boost power converter, which can maximize the high rated voltage using half the actual number of batteries required, can allay this worry. Two Amaron Quanta 6V/21Ah batteries are connected in series for this endeavor, and the voltage is subsequently increased to the rated 48V. Choose the batteries first, followed by the solar controller and solar panels. Since each battery has a voltage of 6V, we must locate solar panels that can each supply the required 6±1V charging voltage in order to get the batteries charged. The Tata BP Solar 20W and 35W solar panels were utilized for this project. Figure 1: Schematic representation showing the entire work flow Hardware testing and simulation studies are conducted once these work-related parameters have been established.

2.1 Relationship between solar module current and voltage

Solar Module — A solar module is made up of several solar cells that are connected in series and parallel to meet electricity needs. MATLAB is used to first model a solar cell in an M-file [1]. Then, using the current-voltage relation equation as described below, the entire module (looking at a 40W solar panel) is modelled. Figure 2, which displays the simulated result of a solar module affected by temperature and irradiance, indicates that the open circuit voltage (Voc) is roughly 43V and the short-circuit current (Isc) is approximately 4.8A. The module voltage first declines precipitously as the module temperature (TaC) rises, whereas the module current decreases more gradually. Similarly, the module voltage changes extremely slowly at larger values of Irradiance (G), but the module current increases very abruptly.

Fig 1: Block Diagram of BLDC

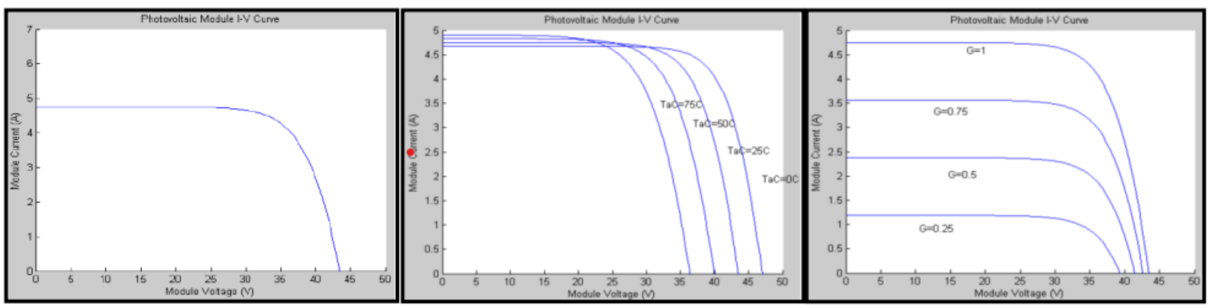

Fig 2: Temperature and Irradiance at 20 W Solar Module

The actual disabling (the unit being considered as a 35W solar module) of the modules were also done by connecting a resistor in parallel with the module. You will now observe the voltage and the current over different resistance values (used rheostat for this). These numbers were used to plot the graph (Fig. 3), which ended up being almost identical to both the manufacturers' graph and the simulated output. Depending on the needs of the application, 20W and 15W solar modules can be linked in parallel or series.

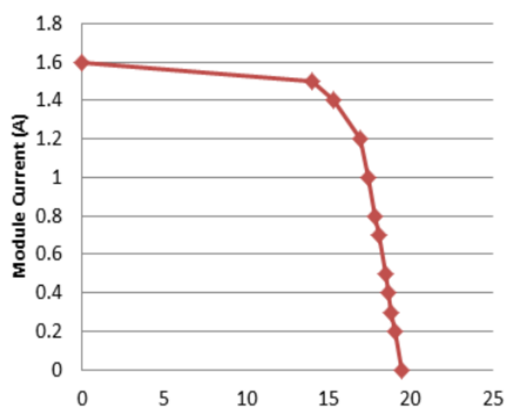

Fig 3: Voltage vs Current on cloudy weather

2.2 Using the charge controllers to charge the batteries

The charge controller limits the amount of electricity that may be extracted from and added to electric batteries. The charge controller's primary job is to prevent deep drain and overcharging of a battery. 1.0- A 6V/3A solar charge controller is an excellent choice for 6V/21Ah batteries. The battery and solar module ratings determine which charge controller is best. Two charge controllers for the 25W and 20W solar panels and batteries are linked independently. After that, the battery is examined and simulated. Figure 4 depicts the battery as a straightforward regulated voltage source connected in series with a constant resistance. The charge and discharge cycles in this model are assumed to be identical. A non-linear equation is utilized to ascertain the open voltage. Thus, the first stage of using the sun to generate energy comes to an end. The solar modules capture solar energy, which is subsequently transferred to batteries through a charge controller. Fig. 6 depicts the work's initial phase.

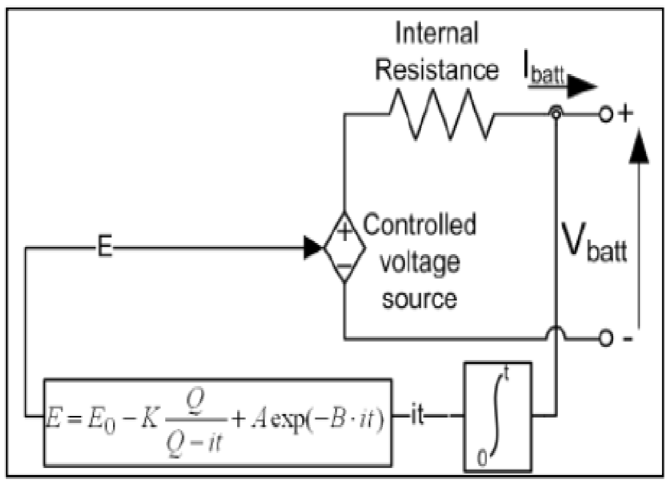

Fig 4: Battery Model Non-Linear System

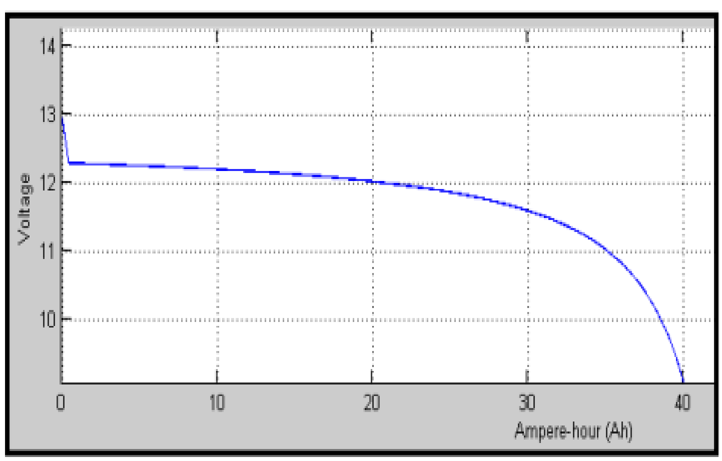

Fig 5: Battery Discharge curve

Thus ends the initial phase; harnessing the sun for energy. The solar energy is harnessed from the solar modules and then charged into batteries via charge controller. The first step of the work is shown in Fig. 6.

Fig 6: Getting Power from the sun to the solar panel

III. Energy from Batteries to the Motor

The power stored in batteries is used in the following step of the project to power a BLDC motor. At this stage, the motor is thoroughly examined and simulated. Given that the specification states that a motor requires 24V of voltage and that one battery's rated input voltage is 6V, four batteries connected in series are needed to achieve the motor's specified voltage. Therefore, it is cost-effective to connect two in serial since you will receive 24 volts at the output end. The boost converter then raises the 12V from the serially connected batteries to 48V.

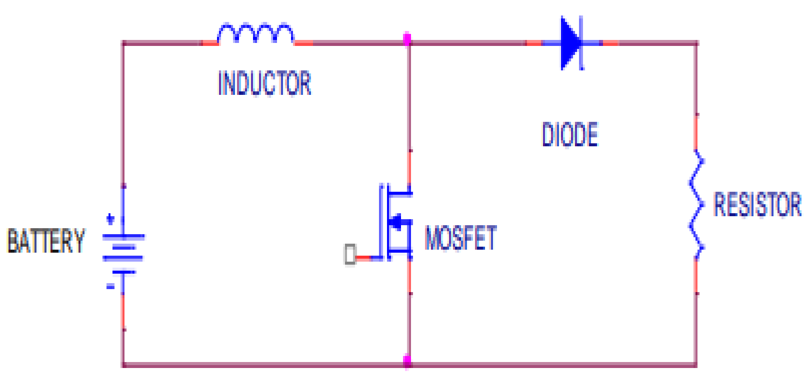

Fig 7: Boost converter circuit

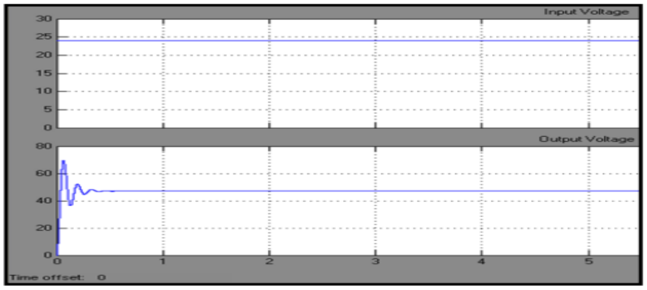

Fig 8: Boost converter Input and Output voltage

The boost converter's switch diode needs to be rated for reverse voltage at least as high as the circuit output voltage and the worn max output current. Diode: The reverse breakdown voltage of a suitable diode should be higher than the circuit output voltage. This type of diodes is generally Schottky barrier diode. The transition at the output will lead to discontinuous current in RC circuit used for plating anode. By limiting the output voltage ripple, a larger size filter capacitor is required. When the diode goes off, the filter capacitor has to supply the output DC current to load.

IV. System Integration

The solar panel, solar charge controller, batteries, boost converter, and BLDC motor are all parts of the integrated system. Fig. 9 displays the whole setup schematic diagram. We see that when the batteries are recharged using solar modules, the boost converter's input voltage continues to decrease since the batteries deplete with time. The load on the battery affects the discharge rate. The complete system process flow is displayed in Table 8. Here, the solar module is connected to charge batteries. We increase the voltage from 24 to 48 volts based on the BLDC motor's operating voltage by connecting the batteries in series. Following this, current readings of 0.9A are found, which the boost converter then cuts in half to 0.45A. The current increases gradually as the motor speed is increased until it reaches a maximum.

Fig 9: Boost converter hardware design

IV. Conclusion

Economical energy source modifications were studied, and the use of solar power in automotive processes was introduced. The goal of choosing the appropriate pieces for usage was investigated, and the remaining parts were put through a number of tests that were compared to the outcomes of simulations. The entire system design takes into account the application for which it is being utilized, and components ranging from a motor to solar modules are chosen accordingly. The initial motor was chosen based on the application. The solar charge controllers and solar modules were chosen based on the motor rating after the battery that could supply both its starting current and full load current was chosen. The vehicle prototype, which had a BLDC motor placed on the frame, was tested under various load conditions.

References

[1] Albert Francis, Mahendra singh and Sk Mehaboob singh Francisco M. González-Longatt, Study Analysis of BLDC for PV module, Bobay, IEEE conference, 2012

[2] Roberts kolagani, Niharika and sai Pallavi, “Research methodology on BLDC with grid”, Guru nanak institutes, Hyderabad, Springer conference, pp; 452-462

[3] King sley, VSRK Prasad and Srikanth, “Go green technology with brush less motors”, IEEE conference, HITAM, Hyderabad, vol 2, Issue 5, pp:142-158.

[4] N.Rana Singh and J.K. Tony Lee, “Distribution of Wireless Networks using Relays Concepts: Open Discussions in Relay Networks, ” Springer Volume 09, Issue 02, January. 2012 Page(s):67-82

[5]. M. Lohit Khan, S. Manoj Yadav and E.Rohit Kapoor Sivakumar, “Implementation of Space Time Space Codes in Diversity Relay Networks” Workshop on Wireless Communication, 2010. Proceedings. Conference on 09-11 November. 2008 Page(s):18-26

[6]. C.Sohail Khan, P.S.Arbaz Khan and Sk.Islam, “Wireless Relay Networks in MIMO Designing Concepts throughput enhancement in wireless ad hoc networks” Areas in Wireless Communications, IETE Journal on Volume 12, Issue 8, December 2010 Page(s):67 – 92

[7]. D. Vijay Kumar, A. Rahul Singh and M.Mohit Singh, “Satellite Relay Networks in MIMO Technology in Ad Hoc Concepts” INCECERT 2012. Proceedings Volume 9, 12-17 September. 2008 Page(s):312 - 32