DUAL BATTERY MANAGEMENT IN ELECTRIC VEHICLE USING SOLAR AND WIRELESS CHARGING

Rishikumar NA
School of Electrical and Electronics Engineering
Vellore Institute of Technology
Chennai, India
rishikumar.na2020@vitstudent.ac.in

Rohan B
School of Electrical and Electronics Engineering
Vellore Institute of Technology
Chennai, India
b.rohan2020@vitstudent.ac.in@vit.ac.in

Jasper Joshuva A
School of Electrical and Electronics Engineering
Vellore Institute of Technology
Chennai, India
jasper.a2020@vit.ac.in

Abstract— **Electric vehicles have now hit the road worldwide and are slowly growing in numbers. Apart from environmental benefits electric vehicles have also proven helpful in reducing cost of travel by replacing fuel by electricity which is way cheaper. Well, here we develop an EV charging system that solves with a unique solution. This EV charging of vehicles without any wires, no need of stop for charging, vehicle charges while moving, Solar power along with wireless charging through underground coils for keeping the charging system going. The system makes use of a solar panel, battery, transformer, regulator circuitry, copper coils, AC to DC converter, mutual inductance coils to develop the system. The system demonstrates how electric vehicles can be charged while moving on the road, eliminating the need to stop for charging. Thus, the system demonstrates a solar co-powered wireless charging system for electric vehicles that can be integrated in the road.**

Keywords—EV Charging, Wireless charging, AC to DC convertor, Copper Coils, Battery, Transformer, Regulator Circuitry, Mutual Inductance Coil.

I. Introduction

Electric vehicles (EVs) have gained popularity due to their ability to reduce carbon emissions and utilize renewable energy sources as their main source of supply. Since the EV's operate on a fixed amount of power supply their range of covering distance is restricted and the time required for charging the battery is also high, which present significant challenges. The utilization of solar energy to charge the EV battery is one solution [1] but since the input from solar is restricted to daylight and has a limited range of supply. So, additionally we are going to use wireless charging model through the electromagnetic coils which can charge the car while in-motion aiding the solar power system which can pose a solution to this challenge. From [2], This has resulted in the creation of three-stage dual battery chargers for EV's. Several research studies like [3],[4] have looked into the usage of wireless battery chargers for EVs. According to review of the literature, many of these studies [5] have focused on developing better algorithms to increase the efficiency of the dual battery charging system. Other research initiatives [5] have concentrated on the development of solar-optimized battery charging system. These algorithms [6] take into account the battery's characteristics, such as its state of charge and temperature, to maximize charging efficiency and battery life. The dual battery chargers using solar panel and wireless charging have the potential to improve EV charging efficiency and range while simultaneously lowering greenhouse gas emissions. Further study, however, is required to optimize the performance of these systems, notably in battery charging algorithms, and control systems.

II. Theoretical Approach

Our objective is to simulate a dual battery management system with solar and wireless charging as the energy source in Simulink. Both the batteries will be charged by the solar and wireless charging technology. Firstly, both the current outputs of solar and wireless charging systems will be compared then that one source which has a higher output at that particular instant of time will be directed to the charging input port of the battery The solar will operate on the principle of diode and the wireless charging will operates in the principle of magnetic resonance. The dual battery management system consists of 2 Lithium-ion batteries. Firstly, the car will run on the lithium-ion battery. There will be a DC-bus which will swap the lithium-ion with its neighbour at the time of fully discharged. At the time of the second lithium-ion battery in use the first one will be charged and at the time of low battery level vice-versa happens to assume the role of supplying power to the vehicle. So, the switching between both batteries occurs simultaneously when the battery is fully charged and ready for use and the other runs out of charge.

III. Simulation Studies

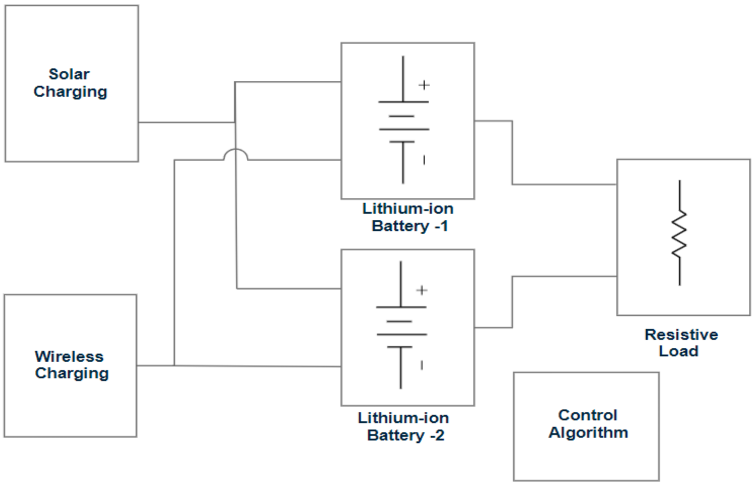

Figure 1. Circuit diagram of the dual battery management system

First there are two subsystems that contains two energy sources that is solar and wireless with two output ports where each of the ports is connected to both Lithium-ion battery blocks and the selection of the power source among the two would be decided with respect to the situation if the vehicle is parked in a crowded place that embodies a wireless charging system it would be given the priority or else if it is in motion then the solar charging system would come into play. After the power source has been decided the next phase would be charging and discharging of the batteries. Henceforth the SOC level of the first battery is calculated and the control algorithm coded in MATLAB will decide whether it should be discharged or charged and if the result is determined then the power source would be charging the battery with a lower SOC simultaneously with the other one that is being discharged.

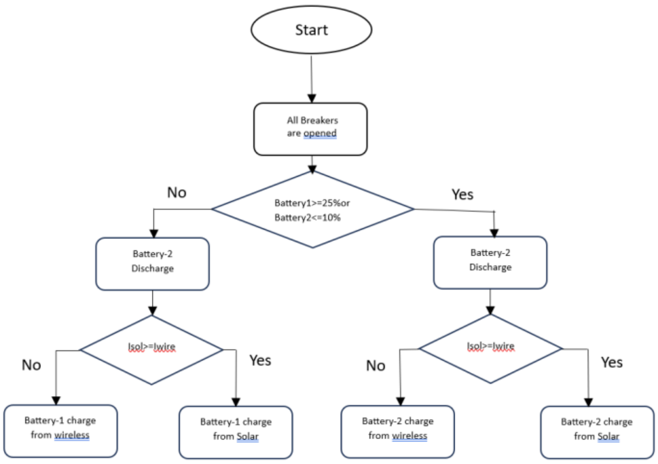

Figure 2. Code snippet of 1st C-function block controlling the two sources and both the batteries

This the code present in the 1st C-function block checks the SOC levels of both the batteries and if the level of the 1st battery is greater than 5 percent and that of 2nd battery is greater than 1 then the prior would be ready to discharge into the load and the successor would enter charging mode and while taking charging in as the condition another subclass of code comes into picture after we find the one to discharge it smoothly compares the current outputs of both the sources and figures the one with the higher output that will be charging the other battery. Now in the vice-versa condition where the SOC of the 1st battery is less than 5 or the 2nd battery is greater than 1 then the 2nd battery would enter into discharging mode while the 1st one is getting charged

Subsystem1:
Solar power charger

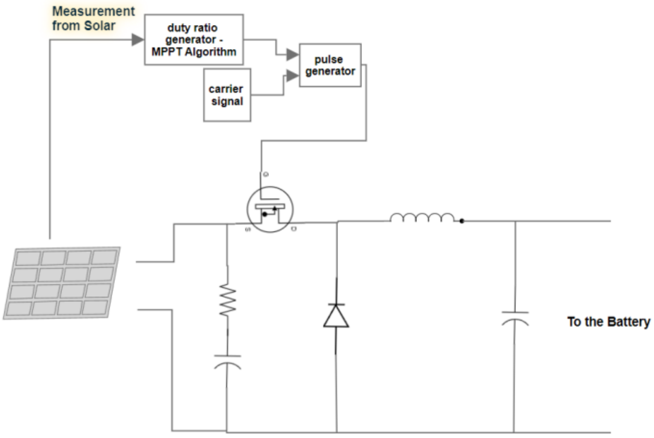

Figure 3. Circuit diagram of the solar power charger

This solar power charger has two input ports which receive the irradiations from the sun and its maximum operating voltage is 32v,rated power is 416W and rated current is 13A and apart from this there is also a MPPT system included which considers the highest power generated at that instance of time and using a PWM generator it sends the required power as the reference to the IGBT which in turn does the switching to allow the current to pass through the circuit so as to ultimately bucking the voltage to 24V.The output power seen is around 380W and efficiency mounting up to 96%

Subsystem 2:
Wireless power charger

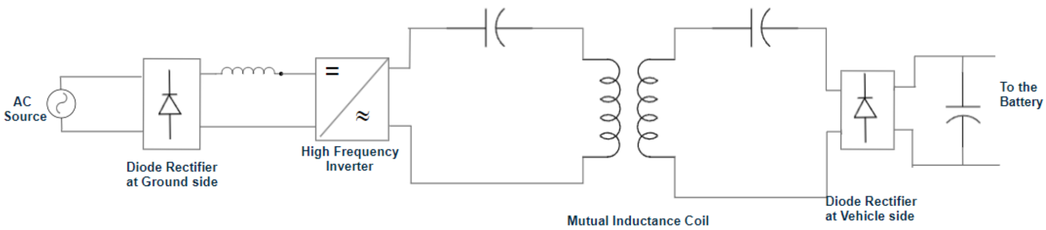

Figure 4. Circuit diagram of the wireless charging system using induction coils

This is the complete circuit of a wireless charging model using the induction coils where first the AC power is pushed through a source which is then passed through a source rectifier which rectifies the AC input to DC and also makes the power factor correction after that the rectified voltage is sent to the inverter such that the DC voltage is converted into a AC voltage of frequency range 80-120 kHz as it is a necessary measure to pass them through the induction coil then again the AC voltage is rectified to DC through a Load rectifier and after which it is ready for deployment

IV. Experimental Verification

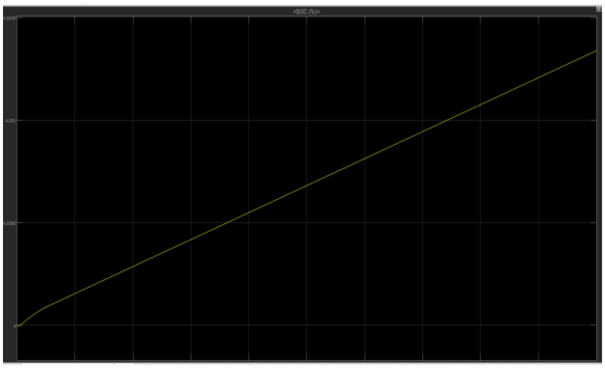

Figure 7. Battery under charging condition

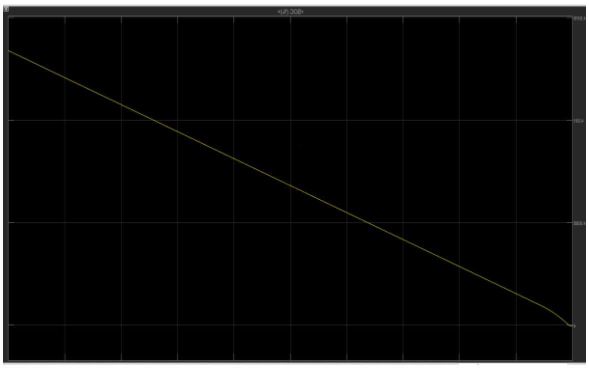

Figure 8. Battery under discharging condition

V. DESIGN SPECIFICATION

Wireless charging through Induction coil:
Peak source voltage:325V
Frequency:50Hz
Vout:24V
Iout:13A
Input power=530W
Output power= 480W
Efficiency = (Output power/Input power) *100
= (480/530) *100
Efficiency = 90.56%

Solar panel:
Irradiations-1000 Wb/m2
Temperature-25C
Maximum power-416W
Cells per module-61
Vmp=32V
Imp=613A
Efficiency=95%

VI. CONCLUSION

In conclusion, the design of electric vehicle charging with an intertwined PV and a on-road wireless system has been successfully designed and enforced. The design aimed to give a sustainable and effective result for EV charging by using exercising renewable energy sources and wireless charging methods.
It is obvious that environmental and energy-related challenges make vehicle electrification necessary. Compared to wired charging, wireless charging offers a number of advantages. The basis for EV mass market acceptance, regardless of battery type, will be laid when highways are electrified with wireless charging capabilities and the car getting a in-motion solar power converter replacing the conventional charging stations. The wireless charging of EVs is a possibility as technology advances. The charging time is reduced, and the cost of charging is minimized and the energy consumption is optimized. In summary, this design demonstrates the eventuality of wireless charging system with renewable energy integration in EV charging systems, leading to a more sustainable and effective future for the transportation assiduity.

VII. Future Scope

- Increased adoption of renewable energy: With the integration of PV systems, the dependence on grid electricity reduces. This promotes the adoption of renewable energy sources and reduces the carbon footprint
- Cost savings: The integration of PV systems with wireless charging reduces the operating costs for the charging station. This helps in promoting the adoption of EVs
- Improved charging efficiency: Due to the use of dual battery management system and the switching algorithms we can control the usage of the batteries in a correct manner
- Increased demand for smart charging solutions: With the growing demand for EVs, the need for smart charging solutions will also increase. The integration of PV systems with wireless coil charging provides an intelligent and sustainable charging solution.
- Potential for vehicle-to-grid (V2G) technology: The integration of above systems and EV charging stations opens up the possibility for V2G technology. This technology allows the EV to feed excess energy back to the grid, creating a more sustainable and efficient energy ecosystem

REFERENCES

[1]https://www.researchgate.net/publication/361254702_SOLAR_WIRELESS_ELECTRIC_VEHICLE_CHARGING_SYSTEM
[2] A. C. R and A. Ghosh, "Battery Management System in Electric Vehicle," 2021 4th Biennial International Conference on Nascent Technologies in Engineering (ICNTE), NaviMumbai, India, 2021, pp. 1-6, Doi: 10.1109/ICNTE51185.2021.9487762.
[3] T. D. Nguyen, S. Li, W.Li, and C.Mi, “feasibility study on bipolar pads for efficient wireless power chargers,”in Proc. APEC Expo., Fort Worth, TX, USA 2020.
[4] A. Ahmad, M. S. Alam and R. Chabaan, "A Comprehensive Review of Wireless Charging Technologies for Electric Vehicles," in *IEEE Transactions on Transportation Electrification*, vol. 4, no. 1, pp. 38-63, March 2018, doi: 10.1109/TTE.2017.2771619..
[5] Bugatha Ram Vara prasad and K. Aswini, “Design of Bidirectional Battery Charger for Electric Vehicle,” Int. J. Eng. Res. Technol., vol. 10, no. 7, pp. 410–415, 2021, doi: 10.1088/1757-899x/1055/1/012141.
[6] J. M. González-González, A. Triviño-Cabrera and J. A. Aguado, "Model Predictive Control to Maximize the Efficiency in EV Wireless Chargers," in *IEEE Transactions on Industrial Electronics*, vol. 69, no. 2, pp. 1244-1253, Feb. 2022, doi: 10.1109/TIE.2021.3057006
[7] X. Zhou, S. Lukic, S. Bhattacharya, and A. Huang, “Design and control of grid-connected converter in bi-directional battery charger for plug-in hybrid electric vehicle application,” in Proc. IEEE Vehicle Power and Propulsion Conference (VPPC), 2019, pp. 1716–1721.
[8] Bugatha Ram Vara prasad, D. V. S. J. Poojitha, and K. Suneetha, “Closed-Loop Control of BLDC Motor Driven Solar PV Array Using Zeta Converter Fed Water Pumping System,” vol. 04, no. 17, pp. 2795–2803, 2017.
[9] Sagolsem Kripachariya singh, T. S. Hasarmani, and R. M. Holmukhe wireless transmission of electrical power overview of recent research and development, International journal of Computer and Electrical Engineering, Vol.4, No.2, April 2019.

[10] BUGATHA RAM VARA PRASAD, C. PRASANTHI, G. JYOTHIKA SANTHOSHINI, K. J. S. V. KRANTI KUMAR, and K. YERNAIDU, “Smart Electrical Vehicle,” i-manager’s J. Digit. Signal Process., vol. 8, no. 1, p. 7, 2020, doi: 10.26634/jdp.8.1.17347.

[11]A. W. Green and J. T. Boys, “10KHz inductively coupled power transfer-concept and control,”in roc. 5th Int. Conf. Power Electron.Variable-Speed Drives, Oct. 2019,pp.694-699.

[12]Bugatha Ram Vara prasad T.deepthi n.satyavathi v.satish varma r.hema kumar, “Solar charging station for electric vehicles,” Int. J. Adv. Res. Sci. Commun. Technol., vol. 7, no. 2, pp. 316–325, 2021, doi: 10.48175/IJARSCT-1752.

[13] Bugatha Ram Vara prasad, “Solar Powered BLDC Motor with HCC Fed Water Pumping System for Irrigation,” Int. J. Res. Appl. Sci. Eng. Technol., vol. 7, no. 3, pp. 788–796, 2019, doi: 10.22214/ijraset.2019.3137.