Energy Efficient Solar System for Electric Vehicle Charging Unit

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ABSTRACT : *Governmental organizations and nongovernmental organizations are promoting greener solutions through the use of renewable energy sources as the world's resources are running out. In order to reduce carbon emissions and slow down climate change, vehicles must use more electric power and electric power sources must be used less frequently. Therefore, electric vehicles are being developed in order to reduce motor vehicle pollution. These vehicles are powered by solar-powered electricity that can be stored, and they are refueled at electric vehicle smart charging stations, which offer a promising alternative and a long-term, environmentally friendly answer to the energy dilemma. Governmental bodies and nongovernmental organizations are promoting the use of more environmentally friendly solutions as the world's resources are running out.*

Keywords– *Batteries, Charging Station, IoT (Internet of Things), Renewable energy, Solar Panel.*

1. Introduction

One big trend in energy usage that is projected for future smart networks is the rise of battery electric vehicles as the go-to mode of transportation. Electric vehicles (EVs) have become more significant during the past few years as a result of their appeal as a respectable substitute for gasoline-powered automobiles [18]. Since EV adoption is anticipated to become a significant transportation alternative in the future, there has been fruitful debate surrounding it, including discussions aimed at politicians. However, just like gasoline-powered automobiles, EVs need a charging station that enables them to "fill up" their batteries. Even while EVs produce no pollution, the electricity needed to charge their batteries may come from conventional power plants, lessening their appeal as a green means of transportation [20].

This paper is all about the charging station design, working, and uses with the disadvantages of the system [17-19]. Every station consists of a plug that becomes attached to a vehicle, supplying it with electrical power to charge the vehicle. Because solar energy is becoming more affordable and efficient, solar-powered EV charging stations offer a great way to greenify our transportation needs and make electric vehicles environmentally friendly from start to finish. Every electric vehicle has a charging line drawn to it at an electric vehicle charging station [21]. To make the public domain widely available, these charging channels are transmitted to the quality separation range in a manner similar to how regular cars with gasoline engines fill up at a gas station. The charging stations are a place to charge electric vehicles, and since they're important for recharging batteries, it's important to keep an eye on how they're doing within the Internet of Things. It is challenging to build an E-car charging station from a remote end because the current system of scarcity lacks scalability, and it only allows for one angle of inclination for the solar array to produce electricity [14-16].

2. Literature Survey

Takadir S Pinjari et.al. (2016), Solar Charging Station for Electric Vehicles. Electricity from the solar charging station can be used to recharge the battery. Operating off-grid is possible because to the charging station's built-in battery storage. The DC charging uses the DC power from the photovoltaic panels. [1]. Arun Kumar P et.al. (2018), IoT Enabled smart charging stations for electric vehicles. Smart grids built on the Internet of Things (IoT) now have the ability to track the health of their batteries. A cloud platform and Android apps are used in the development of the IoT here [2]. Prof.Vishal K. Vaidya et.al. (2020), Solar-based Electric Vehicle Smart Charging Station. The solar-powered charging station aims to reduce reliance on fossil fuels and finite resources while creating ecologically friendly, self-sustaining, outdoor energy sources [3]. Yazan Aloqaily et.al. (2021), Design of a 50 kW Solar PV Powered Charging Station for EVs. The rise in electric vehicle (EV) sales, which is encouraged by the need for a clean environment, has increased electricity demand. The need for public car charging infrastructure for plug-in electric vehicles (PEVs) is rising [4]. Tejas Sonawane et.al. (2019), Solar-Based Electric Vehicle Charging Station. It will be a green energy system if we produce electricity utilising solar and wind energy. Future transportation can be made sustainable by using solar energy for EV workplace charging. This study examines dynamic charging for solar-powered EV charging stations [5]. Esha Sharma et.al. (2019), IoT-Enabled Smart Charging Stations for Electric Vehicles. IoT is the foundation for the user and vehicle's connectivity. By examining the battery's condition, a user can decide on power management and whether to give extra charge to other programmers [6].

3. Methodology

Proposed block diagram of Energy Efficient Solar System for Electric Vehicle Charging Unit is shown in Fig.1. It consists of Solar Panel, Regulated Circuit, Battery Pack, Inverter, Relay, ESP 32 and Sensors.

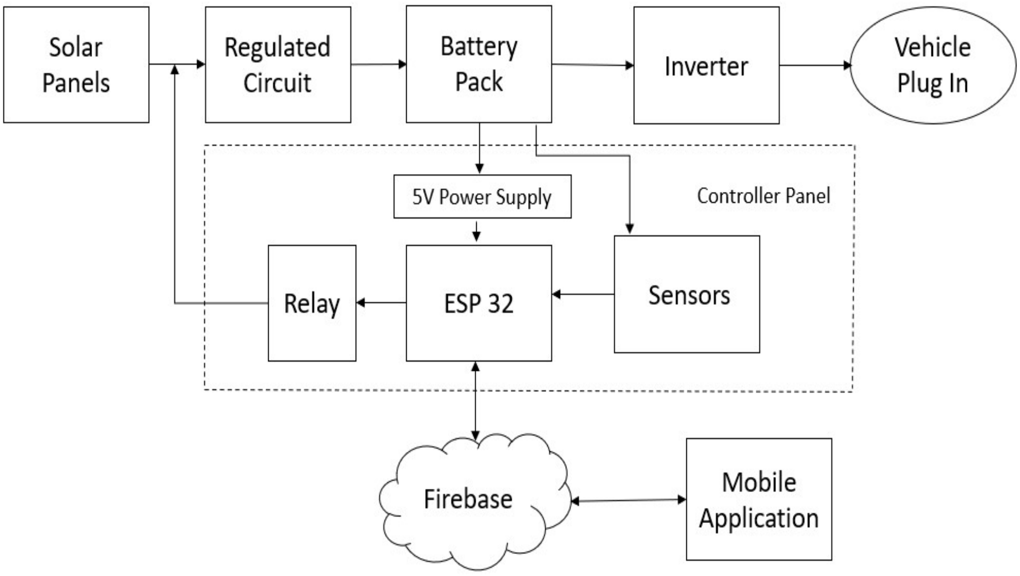

Fig.1 Block Diagram of EV Charging Station

3.1 Solar Panel

The regulator circuit for charging the battery receives a feed from the solar panel. A solar panel generates energy by allowing photons, or light particles, to dislodge electrons from atoms. Photovoltaic cells, a type of smaller unit used in solar panels, are numerous. This implies that they use sunlight to generate electricity. A solar panel is made up of several connected cells. The sandwich-like structure of a photovoltaic cell is formed of two semi-conducting material slices. Silicon, the same material used in microelectronics, is typically utilized to make photovoltaic cells. Photovoltaic cells require an electric field to function [8–9]. An electric field develops when opposing charges are separated, much like a magnetic field develops when opposite poles are present. The producers "dope" silicon to obtain this field.

3.2 Regulator Circuit

Use a voltage regulator IC whenever a consistent, precise, and fluctuation-free voltage is required. They offer a constant, regulated power source. For positive power supplies, we have voltage regulators in the 78XX (7805, 7806, 7812, etc.) series, and for negative power supplies, 79XX. However, if the power supply voltage needs to be changed, the LM317 Variable Voltage Regulator IC is employed. It is a three-terminal adjustable voltage regulator integrated circuit (IC) with a high output current of 1.5A. Current limiting, thermal overload protection, and safe operating area protection are all made possible by the LM317 IC. For high voltage applications, it can also provide float operation. The adjustable terminal can be disconnected without affecting the LM317's ability to defend against overload. It has a normal 0.1% load and line control. This is also a Pb-free device. As the LM317 has an output voltage range of 1.25v to 37v DC. To adjust the output voltage by two external resistors connected through the adjustable pin of the IC. The input voltage, it can range from 3 to 40v DC.

3.3 Battery

Electricity is kept in the battery. The voltage regulator will provide information to the battery so it can charge. The market for lithium-ion batteries is expanding quickly, propelled by rising consumer electronics adoption, expanding R&D efforts by businesses and battery manufacturers, rising interest in plug-in cars, and an increase in the demand for battery-powered material-handling equipment in various industries. Additionally, QA/QC procedures for lithium-ion battery manufacturers are being tightened. A lithium battery pack with three or four lithium batteries connected in line makes up a 12V lithium battery. The number of parallel cells and the single cell's capacity together make up the battery's total capacity. It is a new kind of safe and environmentally rechargeable battery [11 – 13].

3.4 Inverter

The article describes a 12V DC to 220V AC inverter circuit that uses a few inexpensive parts. In locations where it is impossible to obtain an AC supply from the mains, inverters are frequently required. The DC electricity is transformed into AC power using an inverter circuit. The use of an inverter circuit can produce high voltage from a low voltage DC source or battery. It is also possible to utilize a DC-to-DC converter circuit, however it has some voltage restrictions. Utilizing IC CD4047, the 12V DC to 220V AC inverter circuit was created. Switching pulse oscillating is what the IC CD4047 does [9]. Switching is performed using the n-channel power MOSFET IRFZ44n. When converting low AC to high AC, the 12-0-12V secondary transformer is employed in the opposite manner as a step-up transformer. The output power is driven by two 2-power IRFZ44 MOSFETs, and the 4047 IC serves as an astable multivibrator with a frequency of about 50 Hz.

3.5 ESP 32

Wroom IC is used by the ESP 32. ESP 32 uses an LM7805 IC to get power from the battery. The Voltage Detector Sensor and Infrared Temperature Sensor provide data to the ESP32. The battery's voltage and temperature are sensed through sensors. We deliver the readings to mobile applications via Firebase utilizing an integrated WIFI module. A relay will be used to automatically shut off the supply from the solar panel after the battery is fully charged. The relay will automatically open the supply when the battery needs to be recharged.

3.6 Sensors

There are two sensors: a voltage detection sensor and an infrared temperature sensor. Infrared rays are used by the temperature sensor to measure temperature. In accordance with the battery's thermal operating range, the sensor is positioned in front of the battery. The sensor will communicate battery information to the controller (ESP32). For battery level monitoring without sensing the signal to the controller, a voltage detection sensor is utilized.

4. Hardware Design and Modeling

Proposed hardware is designed and modeled using Multisim before hardware design. Fig. 2 shows the modeled part in simulation window.

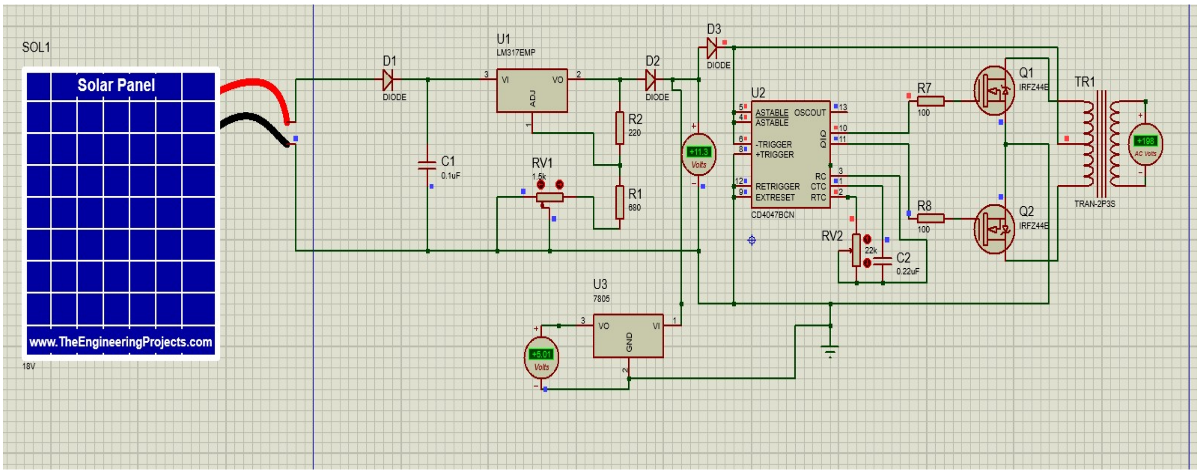

Fig. 2 Simulated model of EV Charging Station

5. Conclusion

In this arrangement, the charging station is not connected to the neighborhood utilities. It is also referred to as an autonomous EV charger as a result. The solar panel array system powers the battery storage. Additionally, this battery storage system provides the entire amount of power needed by the charger. Because it doesn't need to be connected to the grid, this type of charging station can be set practically anywhere. Because the majority of them have a strong steel basis, they are also easy to install. An on-grid solar EV charger costs less than an off-grid one because the energy generated by the solar array is stored in the grid rather than in batteries. When you feed the grid, the utility company supplies you with electricity. The benefits of EV stations are reduced billing fees, zero emissions of carbon and convenience of home charging to reduce time to reach to service station.

REFERENCES

[1] C. Chellaswamy, V.Nagaraju, R.Muthammal" Solar and Wind Energy Based Charging Stations for Electric Vehicles", Professor, Rajalakshmi Institute Of Technology, Chennai, Tamilnadu, India .vol.7, Issue 1, January 2018.

[2] G.R. Candra Mouli, P. Bauerⁿ, M. Zeman," System design for a solar-powered electric vehicle charging station for workplaces", Department of Electrical Sustainable Energy. Delft University of Technology, Mekelweg 4, 2628 CD Delft, The Netherlands.11 February 2016.

[3] Stephen Lee, Srinivasan Iyengar, David Irwin, Prashant Shenoy University of Massachusetts, Amherst," Shared Solar-powered EV Charging Stations: Feasibility and Benefits".2016.

[4] Bin Ye 1, †, Jingjing Jiang 2, 3, †, Lixin Miao 1,*, Peng Yang 1, Ji Li 3 and Bo Shen 4," Feasibility Study of a Solar-Powered Electric Vehicle Charging Station Model", Published: 23 November 2015.

[5] Kondracki, Ryan; Collins, Courtney; Habbab, Khalid," Solar Powered Charging Station" Faculty Advisor: Bijan Karimi, PhD. Department of Electrical and Computer Engineering and Computer Sciences University of New Haven West Haven, CT. ASEE 2014 Zone I Conference, April 3-5, 2014.

[6] Prabhakar, Bhavya M., J. Ramprabhakar, and V.Sailaja. "Estimation and controlling the state of charge in battery augmented photovoltaic system." In Power and Energy Systems: Towards Sustainable Energy (PESTSE), 2016 Biennial International Conference on, pp. 1-6. *IEEE*, 2016.

[7] JK. Kaldellis, D. Zafirakis, "The wind energy (r) evolution: a short review of a long history," Renew Energy, vol. 36, no. 7, pp. 1887-1901, 2011.

[8] G. Bekele, B. Palm, "Design of a photovoltaic-wind hybrid power generation system for Ethiopian remote area," Energy Proceedia, vol. 14, pp. 1760-1765, 2012.

[9] C. Chellaswamy, R. Ramesh, "Future renewable energy option for recharging full electric vehicles," Renewable and Sustainable Energy Reviews, vol. 76, pp. 824–838, 2017.

[10] FH Fahmy, NM Ahmed, HM Farghally, "Optimization of renewable energy power system for small scale brackish reverse osmosis desalination unit and a tourism motel in Egypt,"Smart Grid Renewable Energy, vol. 3, pp. 43-50, 2012.

[11] O. Hafez, K. Bhattacharya, "Optimal planning and design of a renewable energy based supply system for microgrids," Renewable Energy, vol. 45, pp. 7-15, 2012.

[12] C. Chellaswamy, R. Ramesh, "An intelligent energy management and control system for electric vehicle," IEEE International Conference on Advanced Communication Control and Computing Technologies (ICACCCT), pp. 180-184, 2014.

[13] C. Chellaswamy, R. Ramesh, "An optimal parameter extraction and crack identification method for solar photovoltaic modules," ARPN Journal of Engineering and Applied Sciences, vol. 11, no. 24, 2016.

[14] Basil Jacob, Karthik Balasubramanian, Thanikanti Sudhakar Babu, N. Rajasekar, "Parameter Extraction of Solar PV Double Diode Model Using Artificial Immune System," IEEE International Conference on Signal Processing, Informatics. Communication and Energy Systems (SPICES), pp. 1-5, 2015.

[15] G. Tina, "A coupled electrical and thermal model for photovoltaic modules," J. Sol. Energy Eng., vol. 132, no. 2, pp. 1-5, 2010.

[16] GR. Chandra Mouli, P. Bauer, M. Zeman, "Comparison of system architecture and converter topology for a solar powered electric vehicle charging station," IEEE Int. Conf. Power Electron. ECCE Asia (ICPE-ECCE Asia), pp. 1908-1915, 2015.

[17] C. Chellaswamy, R. Ramesh, "Performance analysis of a wind duct and soc estimation for pure electric vehicle charging," International Journal of Control Theory and Applications, vol. 9, no. 5, pp. 27-43, 2016.

[18] M. Van der Kam, W. Van Sark, "Smart charging of electric vehicles with photovoltaic power and vehicle-to-grid technology in a microgrid; a case study," Appl Energy, vol. 152, pp. 20-30, 2015.

[19] P. Nunes, T. Farias, MC. Brito, "Enabling solar electricity with electric vehicles smart charging," Energy, vol. 87, pp. 10-20, 2015.

[20] SA. Cutler, B. Schmalberger, C. Rivers, "An intelligent solar ecosystem with electric vehicles.," IEEE Int Electr Veh Conf, pp. 1–7, 2012.

[21] P. Kadar, A. Varga, "PhotoVoltaic EV charge station," IEEE 11th Int Symp Appl Mach Intell Informatics, pp. 57-60, 2013.