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Solar Off-Grid Electric Vehicle Charging Station

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Abstract: ***Nowadays, there is a great development in electric vehicle production and utilization. It has no pollution, high efficiency, low noise, and low maintenance. However, the charging stations, required to charge the electric vehicle batteries, impose high energy demand on the utility grid. One way to overcome the stress on the grid is the utilization of renewable energy sources such as photovoltaic energy. The utilization of standalone charging stations represents good support to the utility grid. Nevertheless, the electrical design of these systems has different techniques and is sometimes complex. This paper introduces a new simple analysis and design of a standalone charging station powered by photovoltaic energy. Simple closed-form design equations are derived, for all the system components. Case-study design calculations are presented for the proposed charging station. Other important features of an off-grid solar EV charging station might include the use of smart charging technology to optimize charging speed and efficiency, as well as the ability to monitor and control the system remotely. Safety features such as overcharge protection and grounding would also be important considerations. We can visualize the expected results using a Cayenne Software, we can also control the street lighting by Internet of Things. The results show that the charging process of the electric vehicle battery is precisely steady for all the PV insolation disturbances. In addition, the charging/discharging of the energy storage battery responds perfectly to store and compensate for PV energy variations.***

I. INTRODUCTION

Solar Off-grid electric vehicle charging stations are a type of charging infrastructure for electric vehicles that operate independently of the grid. These charging stations are powered by solar panels, which generate electricity from sunlight and store it in batteries for later use. Off-grid solar electric vehicle charging stations are an innovative solution to the challenges of providing reliable and sustainable charging infrastructure for electric vehicles, especially in remote or rural areas where grid access is limited or non-existent. Solar Off-grid electric vehicle charging stations use the latest technology to provide an efficient and eco-friendly charging solution for electric vehicles. They offer a range of benefits, including reduced dependence on the grid, lower costs, and increased scalability. These charging stations can be easily installed and scaled up as demand grows, making them a flexible and versatile solution for charging electric vehicles. Off-grid solar electric vehicle charging stations are also a sustainable and eco-friendly solution, as they use renewable energy sources and reduce carbon emissions. EVs provide high efficiency, reduced noise and negligible emission advantages. EVs can be classified as Battery EVs (BEV), Hybrid EVs (HEV) and Fuel cell EVs (FEVs). Since BEVs get their power from the batteries, these batteries need to be charged. EVs, unlike ICE vehicles, do not release any GHG and are a smart way to reduce dependence on the environment. EVs are the future of transportation since they substantially minimize the consumption of fossil fuels. EVs are being promoted in both developed and developing countries as a way to improve energy efficiency and green energy technologies.

II. LITERATURE SURVEY

1) "Design and Analysis of a Solar-Powered Electric Vehicle Charging Station for India Cites" by Aanya Singh, Shubham Sanjay Shaha and Nikhil P G published in the Journal of Solar Energy Research Updates in 2021. This study focused on designing and analysis of a solar-powered electric vehicle charging station, considering the energy requirements of electric vehicles and the capacity of solar panels.

2) "Solar Based Charging Station for E-Vehicle" A Gayathri, C Prasanna, M Priyanka, M Rahul, K Mohamed Abdullah Department of EEE, Sri Krishna College of Technology, Coimbatore. Tamil Nadu, India.

3) "Experimental solar-based charging station for electric vehicles" D. Rasolomampionona, Francois Maeght, Pierre-Yves Cresson, Patrick Favier Institute of Electric Power Engineering, Warsaw University of Technology.

4) "Designing of Solar Charging Stations for Electric Vehicle" Sahil S Ambavane, Shubham R Bhoir, Somesh S Pimpare, Department of Mechanical Engineering, Mumbai University Pratik A Kulkarni Department of Mechanical Engineering, Mumbai University, Maharashtra, India.

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5) "Development of an Efficient Tool for Solar Charging Station Management for Electric Vehicles" Simon Steins Haden Department for Renewable Urban Energy Systems, University of Applied Sciences-Technikum Wien, 1200 Vienna, Austria. José Baptista Department of Engineering, School of Science and Technology of University of Tras-os-Montes and Alto Douro and INESC-TEC, UTAD's Pole, 5000-801 Vila Real, Portugal.

III. PROBLEM STATEMENT

The growth of electric vehicles (EVs) is a key component of efforts to reduce greenhouse gas emissions and address climate change. However, providing reliable and sustainable charging infrastructure for EVs, particularly in remote and off-grid areas, remains a significant challenge. Traditional EV charging stations rely on grid-connected power, which may not be available or reliable in remote locations. Moreover, the use of traditional fossil fuel-powered generators to provide off-grid charging solutions is not sustainable, and poses environmental and economic challenges. The problem, therefore, is to develop a reliable and sustainable off-grid solar electric vehicle charging station that can provide reliable power for EVs in remote and off-grid areas. This solution should be able to operate efficiently in a wide range of weather conditions and be economically viable, providing a cost-effective solution for charging EVs in off-grid areas. Such a solution will help promote the adoption of EVs in remote areas, reduce dependence on fossil fuels, and contribute to the transition to a more sustainable and environmentally friendly transportation system.

IV. PROPOSED SYSTEM

The architecture of the proposed Electric Vehicle Charging Station system is shown in Figure. The EVCS system is an off-grid type that is powered by solar energy. It is collected by a Solar PV array that generates electrical energy to the EVCS. The PV panel represents the main source of energy for the charging station. However, the generated energy is not steady. It varies according to the solar isolation level and other environmental issues. Hence, batteries are usually used to compensate for the problem of energy intermittence. The output terminals of the Battery are connected to a Voltage regulator and Charge controller. Voltage regulator is also known as buck converter IC ideally suited for convenient design of a step−down or step-up switching regulator. Charge controller module is perfect for charging single cell 3.7V 1 Ah or higher LiPo cells. TP4056 charger IC module offers 1A charge current. The module cuts off charging current when finished. Both the output is connected to a Micro-controller (ESP32), along with two sensors i.e., Voltage and current sensor are used to measure the voltage and how much current is drawn during the charging process. ESP-32 module that combines Wi-Fi and Bluetooth connectivity with powerful processing capabilities. It is based on the Espress if ESP32 system-on-chip (SoC). DHT-11 sensor is used to measure temperature and humidity which is connected to ESP-32. GSM module is used to monitor the system. You can use this module to monitor from anywhere by a normal cell phone just by sending SMS messages, connecting to the Internet via GPRS. And the output of ESP-32 is connected to an OLED display. Where we can visualize the current, voltage rating battery percentage. By using IoT (Internet of Things), we can visualize the result through the web interface.

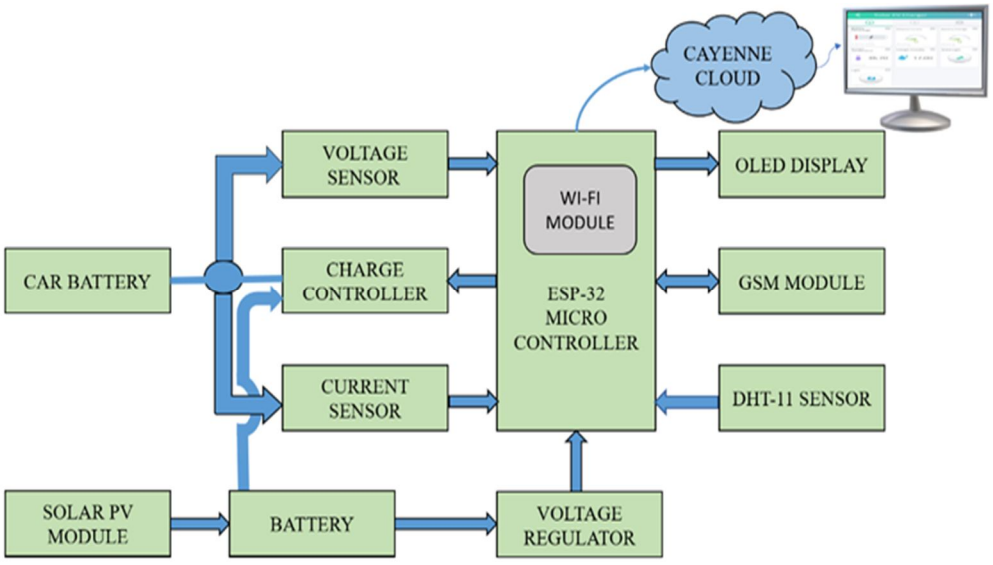


Fig 1: Proposed system architecture

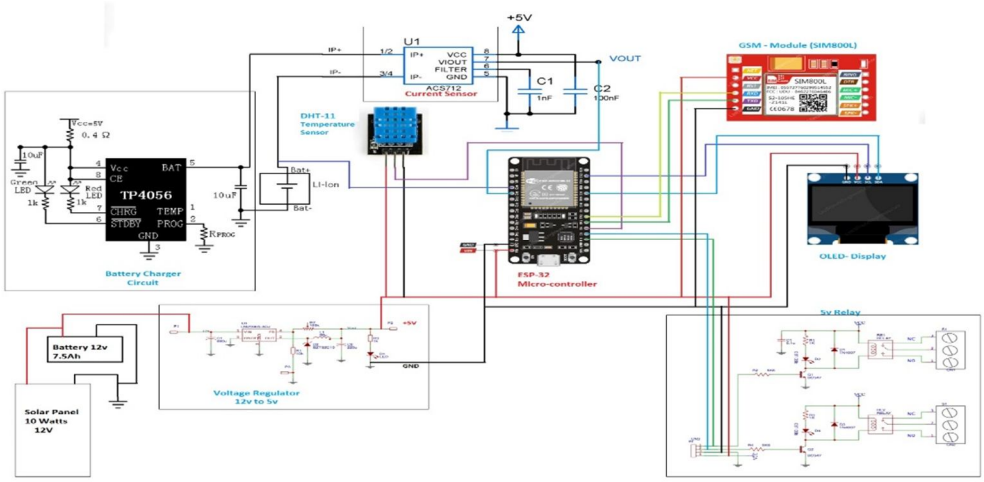


Fig 2: Hardware design

V. RESULT & DISCUSSION

A. *Result*

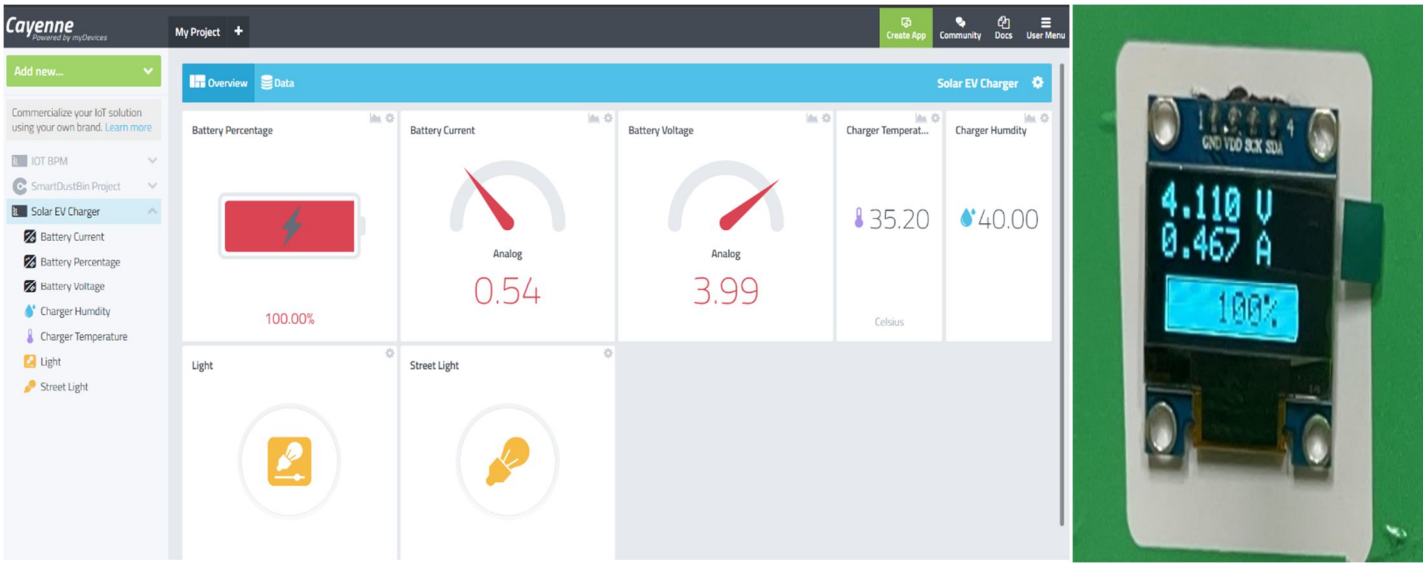


Fig 3: Cayenne Web interface using IOT

B. *Discussion*

As the title says, the result of SOLAR OFF-GRID ELECTRIC VEHICLE CHARGING STATION is of extreme use to charge the electric vehicles. Solar Off-grid electric vehicle charging stations are a type of charging infrastructure for electric vehicles that operate independently of the grid. These charging stations are powered by solar panels, which generate electricity from sunlight and store it in batteries for later use. Off-grid solar electric vehicle charging stations are an innovative solution to the challenges of providing reliable and sustainable charging infrastructure for electric vehicles, especially in remote or rural areas where grid access is limited or non-existent. By using Iot (Internet of Things), we can visualize the result through the web interface like, how much current its drawing while charging the car battery, and we can check the voltage level. By placing a temperature sensor, we can visualize the temperature and humidity level, this is a safety precautions for battery to prevent by overheating. We can also control the lighting of the system by

Switching action using IoT, which makes the owner easy to work and also saves the time. Since, it is a prototype model, our system shows the almost real time. A sample screen shot of the web interface can be seen in Figure.

VI. CONCLUSIONS & FUTURE SCOPE

Solar off-grid EV charging stations are a sustainable and environmentally-friendly solution to charging EVs. They offer numerous benefits such as cost-effectiveness, reliability, and independence from the grid. However, they also have some challenges such as high initial cost, limited charging capacity, and battery maintenance. Overall, solar off-grid EV charging stations have the potential to play a significant role in the future of sustainable transportation.

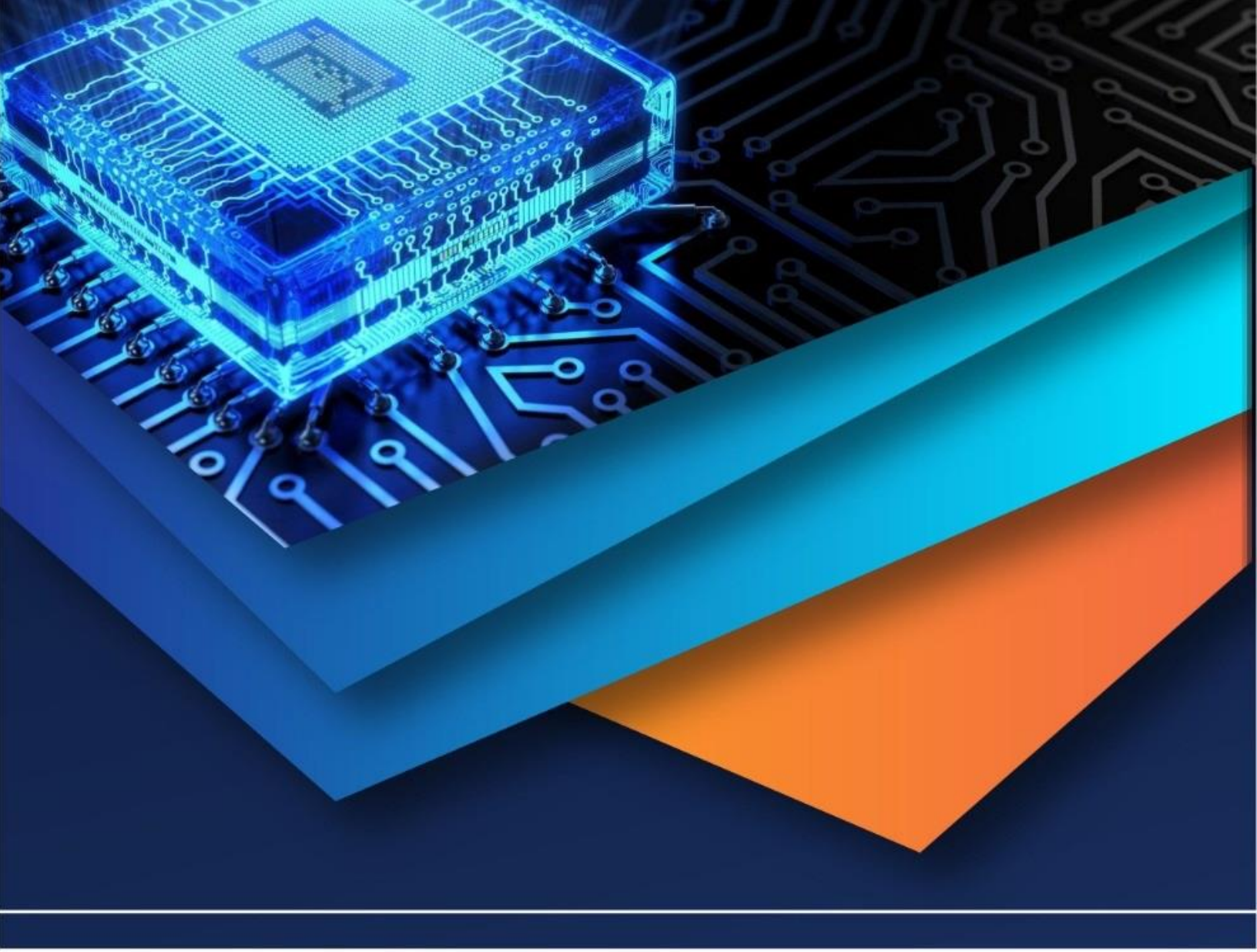
1) *Increased Demand For Electric Vehicles:* As more and more people opt for electric vehicles, the need for charging stations will grow. Off-grid solar electric vehicle charging stations provide a viable alternative to traditional charging stations, especially in remote areas where there is no access to the grid.
2) *Reduced Dependence On The Grid:* Off-grid solar electric vehicle charging stations are self-sufficient and do not require connection to the grid, making them an ideal solution for areas with unreliable power supply or limited access to the grid.
3) *Sustainable And Eco-Friendly:* Solar electric vehicle charging stations are powered by renewable energy, reducing the carbon footprint of electric vehicles and promoting sustainable living.
4) *Cost-effective:* Solar energy is becoming more affordable, and off-grid solar electric vehicle charging stations can offer a cost-effective solution for charging electric vehicles.
5) *Scalability:* Off-grid solar electric vehicle charging stations can be easily installed and scaled up as demand grows, making them a versatile and flexible solution.
6) *Emergencies And Disasters:* In case of emergencies or natural disasters, off-grid solar electric vehicle charging stations can provide a reliable source of power for electric vehicles and other devices.

Overall, off-grid solar electric vehicle charging stations have a promising future, and as technology advances and costs continue to decrease, they are likely to become even more popular and widespread.

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