



IoT Based Solar EV Charging System

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ABSTRACT: Solar-powered EV adaptive chargers provide an eco-friendly solution for electric vehicle charging by utilizing renewable solar energy. However, conventional EV charging systems suffer from drawbacks such as dependency on grid power, inefficient energy utilization during variable sunlight conditions, and lack of intelligent charging control. These limitations highlight the need for adaptive solar-based charging systems that optimize power usage, improve charging efficiency, and reduce grid dependency. The system integrates a solar panel and solar battery charger to harvest and store energy, ensuring uninterrupted charging availability. Overall, the smart solar-based IoT EV charging system offers a cost-effective, eco-friendly, and scalable solution for sustainable electric vehicle infrastructure, contributing to reduced carbon emissions and improved utilization of renewable energy resources.

Keywords: Internet of Things (IoT), Enhanced Charging Technology, eco-friendly, cost-effective, Improved Charging Infrastructure.

1. Introduction

Solar-powered EV adaptive chargers provide an eco-friendly solution for electric vehicle charging by utilizing renewable solar energy. However, conventional EV charging systems suffer from drawbacks such as dependency on grid power, inefficient energy utilization during variable sunlight conditions, and lack of intelligent charging control. Therefore, this project proposes a Design and Implementation of a Smart Solar-Based IoT EV Charging System, which utilizes renewable solar energy combined with IoT-enabled monitoring and control.

2. Objectives

To design a solar energy harvesting unit using a solar panel and charge controller for efficient power generation and storage. To integrate IoT

connectivity using a wireless module for real-time data transmission, monitoring, and remote control.

To implement a controlled EV charging mechanism using relay-based load management for safe and adaptive charging.

3. Literature Survey

Fossil fuels are used to meet the majority of the world's energy needs. Natural gas, crude oil, coal, heavy oils, etc. account for nearly 85% of all energy production. The conditions of the atmosphere are being negatively impacted by these resources (Nabavi et al., 2021). Renewable Energy Resources (RERs) has several advantages over these resources. Putthiphong Kirdpipatet *al* [2023] have presented the limitations of Blynk-based solar monitoring by proposing a cross-

platform mobile application for Android and iOS. The system is developed using the Ionic Framework with Cordova, enabling unified deployment through HTML, CSS, and AngularJS. Firebase is used as a cloud server to store and synchronize real-time and historical charging data. A solar battery charger is implemented using a buck converter controlled by an Arduino with PWM. Data is transmitted via NodeMCU over Wi-Fi to smartphones. Experimental results show full battery charging in 10–12 hours with a final voltage of 13.8 V.

3.1 Proposed Methodology

The Proposed IoT Based Solar EV Charging System operates by first converting sunlight into DC electricity using solar panels, which is then regulated by a solar battery charger. DC voltage and current sensors continuously monitor the generated energy, sending real-time data to the Arduino Uno microcontroller. Temperature and humidity, are measured with a DHT-11 sensor, while light intensity is detected using an LDR sensor. The IoT-based measurement system may be integrated into larger solar power systems by offering a scalable and adaptable solution, promoting the broader adoption of renewable energy technology. In the following sections, describe the IoT-based solar power measuring system's methodology, architecture, and implementation specifics



The Arduino collects data from sensors and communicates with the ESP-32 to enable IoT-based remote monitoring and control of voltage, current, temperature, humidity, and connected devices. Based on sensor readings and predefined conditions, the Arduino activates the relay driver to switch loads like an EV charger or bulb on or off. The system ensures continuous operation by managing power from solar panels and the 12V battery when needed. . The system ensures sustainable EV charging with remote monitoring, data logging, and intelligent control to improve reliability and reduce grid dependency.

4. Results and Discussion

The smart solar-based IoT EV charging system integrates a photovoltaic panel, charge controller, and microcontroller to harvest and manage renewable energy efficiently. IoT-enabled sensors and communication modules monitor solar generation, battery status, and charging parameters in real time for optimized energy utilization. displays the Smart Solar EV Charging Monitor provides real-time visualization of key parameters such as battery voltage, charging current, temperature, humidity, and ambient light conditions. It enables continuous IoT-based monitoring to assess solar availability and charging performance through a simple web interface. This dashboard supports efficient energy management, fault detection, and informed decision-making for sustainable EV charging operations. Integration of AI-based energy

prediction to optimize charging based on weather forecasting and usage patterns.

Expansion to fast-charging stations with bidirectional power flow and vehicle-to-grid (V2G) support.

4.1 Preparation of Figures and Tables

The smart solar-based IoT EV charging system operates by first converting sunlight into DC electricity using solar panels, which is then regulated by a solar battery charger. DC voltage and current sensors continuously monitor the generated energy, sending real-time data to the Arduino Uno microcontroller. Temperature and humidity, are measured with a DHT-11 sensor, while light intensity is detected using an LDR sensor. Based on sensor readings and predefined conditions, the Arduino activates the relay driver to switch loads like an EV charger or bulb on or off. The system ensures continuous operation by managing power from solar panels and the 12V battery when needed.

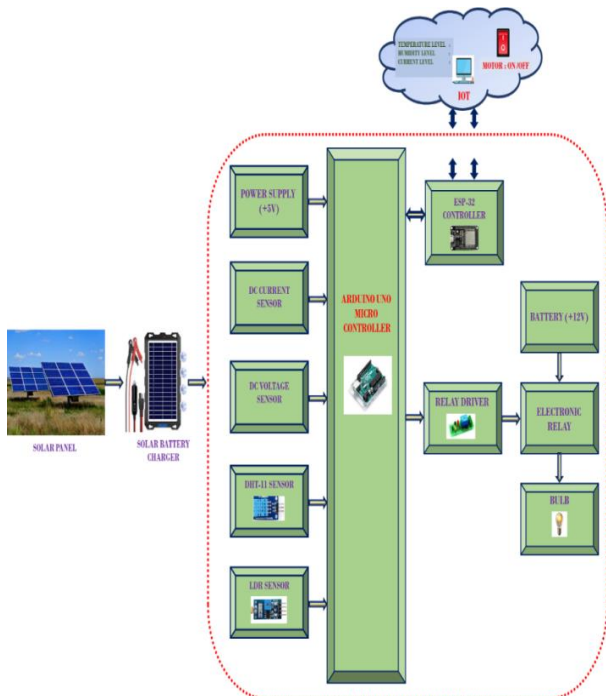


Figure 1: IoT Based Solar EV Charging System

4.1.1 Formatting Tables

Table 1 summarizes the hardware components used in the proposed IoT Based Solar EV

Charging system along with their specifications and functional roles. The table is properly numbered, provided with a descriptive title, and includes relevant measurement units in the column headings for clarity. It is placed appropriately within the manuscript and referenced in the corresponding section to support the explanation of the system design and implementation.

Table 1: Hardware Components Used

Component	Specification	Function
Arduino UNO	16MHz Ceramic Resonator	Data processing
ESP32 Micro-Controller	Wi-Fi enabled MCU	Data processing
DC Current Sensor	Supply Voltage: 4.5V~5.5V DC	Current Sensing
DC Voltage Sensor	66 mV/A output sensitivity	Voltage Sensing

5. Conclusion

In conclusion, the smart solar-based IoT EV charging system successfully reduces dependency on grid power by efficiently utilizing renewable solar energy.

Real-time monitoring of electrical and environmental parameters enables adaptive charging, improving efficiency and safety. Integration of Arduino and ESP32 ensures reliable control, automation, and remote accessibility through IoT platforms. The system provides a cost-effective, eco-friendly, and scalable solution for sustainable EV charging infrastructure.

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