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SMART AND ADVANCED ENABLING TECHNOLOGY BASED EV CHARGING SYSTEM

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Abstract - The main objective of the mini project is to develop the most efficient way to charge electric vehicles independently, without assistance from others. This mini project presents the development of a smart, advanced EV charging system that integrates RFID technology for access control and solar power as an additional energy source. With access granted, this system streamlines the charging process for consumers, enabling them to charge their EVs conveniently. Customers will be issued access cards, which they can use with the EV charging system to initiate the charging process. By placing the charging cable into the vehicle's charging port and registering their attendance with the access card, they can start charging seamlessly.

In addition, this EV charging system employs cloud technology to store customer data securely, allowing for efficient database management at the EV charging station. The cloud-based system supports real-time access and updates, ensuring smooth operation and data security for each registered customer. During the charging session, an LCD display will show the amount due and the total time taken for the charge. Payment can be made through Net banking, Paytm, Google Pay, or Phone Pay. Once the payment is received, the vehicle will automatically start charging. The system will also notify the customer's phone when the vehicle is fully charged. This automated EV charging system not only promotes the use of clean energy but also enhances EV infrastructure, reduces dependency on fossil fuels, and significantly improves the convenience and sustainability of charging facilities.

Keywords - RFID Tags and Reader, Communication Networks, Cloud Platforms, Mobile Application.

1.INTRODUCTION

The transportation sector is undergoing a significant transformation, driven by concerns about climate change, air pollution, and the depletion of fossil fuels. In response to these challenges, electric vehicles (EVs) have emerged as a promising solution to reduce greenhouse gas emissions and reliance on traditional vehicles powered by internal combustion engines. However, the widespread adoption of EVs faces several obstacles, including limited charging infrastructure, long charging times, and the need for advanced technologies to facilitate seamless integration into existing transportation systems. To address these challenges, the development of smart and advanced enabling technology-based EV charging systems has become increasingly crucial. These systems leverage technologies such as Radio Frequency Identification (RFID) to enhance the efficiency, convenience, and accessibility of EV charging infrastructure. RFID technology, which uses electromagnetic fields to automatically identify and track tags attached to objects, offers numerous advantages for EV charging systems, including secure authentication, real-time monitoring, and automated billing. This paper explores the concept of smart EV charging systems. It examines the key components, benefits, and applications of these systems, as well as their potential to accelerate the transition to a sustainable transportation ecosystem.

2. METHODOLOGY

The major drawback of all the existing methodologies is more time consumption. To overcome this drawback, we used fast charge and advanced system in this project which has wide range process depends on the electric vehicles. To charge the Electric vehicle (EV) from charging station through EB, Solar power and Wind power by using RFID (Radio Frequency Identification) for Authorization purpose and future implementation. This charging system is clever. It can do things like track how much electricity your car needs, and it can even communicate with other devices.

The system uses Embedded System high-tech tools and cloud methods to make charging your car easier and more efficient. It's not just a basic plug-in and-charge setup. This stands for Radio Frequency Identification. It's like a special kind of thing that your car and the charging station use to identify the client details. When you come up to the charging station, the consumer can phone to pay for charging your car.

The system includes two main power sources: EB Supply (conventional power from the grid) and Solar power. The EB supply goes through a Transformer to step down the voltage and then a Rectifier to convert AC to DC for charging. Meanwhile, the solar power passes through a Boost Converter to increase the voltage and then charges a Battery, which stores energy for direct use or as a backup when the EB supply is unavailable. At the heart of the system is the Node MCU (ESP32 Dev Module), a microcontroller with Wi-Fi capabilities. The Node MCU connects to the cloud, which stores customer information, usage logs, and payment data. This allows for secure access, data management, and remote monitoring. To start charging, the consumer uses an 11 RFID card to authenticate access. This card is scanned by the RFID reader, and the authentication data is checked against the cloud database.

3. SPECIFICATIONS

For additional control, the system also includes a Keypad for input, like a PIN or account details if required. Once authenticated, the Relay is triggered, allowing current to flow to the EV load. The Voltage Sensor and Current Sensor monitor the power being supplied to the EV and send real-time data to the Node MCU, which can be displayed on an LCD Display.

The LCD also shows information such as the charging cost and time required. After charging, the system provides a billing summary, and customers can pay via digital platforms like Net-banking, Paytm, Google Pay, or Phone Pay. When payment is received, the vehicle begins charging, and a notification is sent to the user's phone once charging is complete.

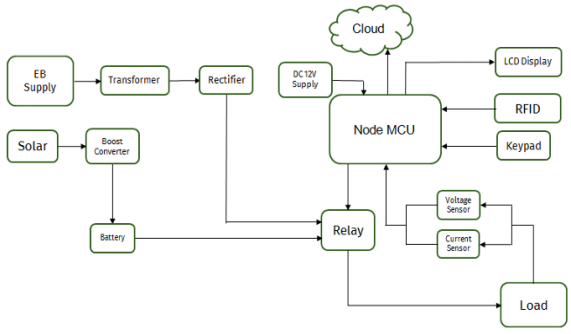

Fig -1: Block Diagram

3.1 Power Supply:

The power supply is a critical component of every charging station, serving as the source of electrical energy necessary to charge electric vehicles (EVs). The primary role of the power supply is to supply electrical energy to the EV charging station. This energy is then transferred to the vehicle's battery through the charging cable and connector. The power supply's capacity, typically measured in kilowatts (kW), determines the maximum charging speed that the station can deliver to EVs. Higher-power supplies enable faster charging, reducing the time required to replenish the vehicle's battery.

3.2 Converter Unit:

The Power Converter Unit (PCU) is an essential component in every EV charging station, responsible for converting the incoming alternating current (AC) power from the grid into the appropriate form needed to charge electric vehicles (EVs).

In the conversion process, the AC grid power first passes through a step-down transformer that reduces the high voltage to a lower level suitable for the charging station, typically required for residential or commercial charging applications. This step ensures that the voltage level is compatible with the EV charging requirements.

After step-down transformation, the AC supply is directed to a rectifier, which converts the AC power into DC output. This DC output is then supplied to the EV's battery or to the onboard charging unit, depending on the charging type.

In DC fast charging stations, the PCU performs a more complex role by converting the AC grid power directly into high-voltage DC power compatible with the EV's battery. Unlike AC charging stations, which rely on the EV's onboard charger to perform AC-to-DC conversion, DC fast chargers bypass this step and provide DC power directly to the EV's battery. To achieve this, the PCU in DC fast chargers typically includes advanced power electronics, such as rectifiers, inverters, transformers, and voltage regulators, ensuring rapid charging speeds and high efficiency.

Power converter unit plays several critical roles:

Voltage Conversion: Adjusting the voltage level of the incoming AC power to match the requirements of the EV's charging system.

Current Regulation: Controlling the amount of current supplied to the EV to prevent overloading and ensure safe charging.

Power Factor Correction (PFC): Improving the power factor of the charging station to minimize reactive power consumption and enhance energy efficiency.

DC to AC Conversion (Solar & Wind): Solar panels and wind turbines generate direct current (DC) electricity, which needs to be converted into alternating current (AC) to be compatible with the grid and EV charging equipment. The PCU performs this conversion, ensuring that the electricity generated by renewable sources can be used to power the charging stations and supply electricity to the grid if necessary.

3.3 Microcontroller Unit:

The brains of the operation, the MCU governs the entire charging process. It receives data, interprets commands, and regulates power flow. A user-friendly interface that is calculate real-time information on charging status, battery percentage, estimated charging time, and potential error messages. An enhanced security feature utilizing Radio Frequency Identification

(RFID) tags for user authentication. The system can be programmed to recognize authorized users and initiate charging upon identification. This system incorporates renewable energy sources like solar panels or a wind turbine to generate electricity for charging. The MCU prioritizes renewable energy and seamlessly switches to grid power when necessary. This innovative unit precisely calculates the remaining battery percentage based on the measured voltage and current. This data is then displayed on the LCD, providing valuable insights to the user. Integrated sensors continuously monitor voltage and current levels, ensuring safe and efficient charging. The MCU utilizes this data to regulate power delivery and prevent potential damage to the battery remaining. This real-time data is displayed on the LCD screen, allowing users to accurately gauge charging progress. This eliminates the ambiguity of "miles to charge" and provides a clearer understanding of the remaining charging time.

3.4 Display Unit:

The LCD display serves as the user interface, providing a plethora of information. It showcases the current charging status (percentage and estimated time remaining), historical charging data, and any error messages. Additionally, the display can present educational content about EV charging and sustainability practices.

To display serves as an interface between the charging station and the user. It shows real-time information such as the cost of the charging session, the amount of power delivered to the vehicle, and the estimated time remaining until the vehicle is fully charged. This information helps users make informed decisions about their charging needs and budget accordingly. Once the payment is successfully processed and received by the charging station, the charging session is initiated. The vehicle's charging system begins delivering power to the EV's battery, gradually replenishing its charge. Users can monitor the progress of the charging session in real-time using the LCD display.

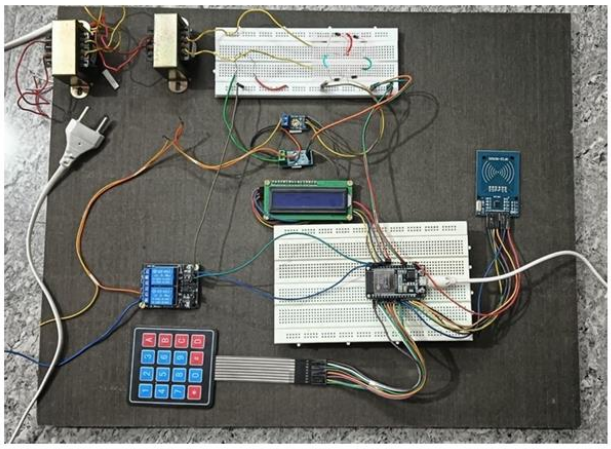

Fig -2: Project Kit

4. RESULTS & DISCUSSION

First, in order to uthorize consumers to use our EV charging infrastructure, we have implemented an access control system. Consumers are issued access cards. This promotes security and user accountability by guaranteeing that only uthorized individuals can access the charging infrastructure. Users only need to take the charging cable and insert it into their vehicle's charging port to start the charging process once they are given access. Customers will have a flawless charging experience thanks to this simple technique, which does away with the necessity for complicated setup processes. In addition, our charging system has an LCD display that shows consumers critical data in real time, including the cost of the charging session, power usage, and expected charging time. Users are able to make knowledgeable decisions about their billing because of this openness.

Benefits of the System:

1. Enhanced Security: RFID access control safeguards against unauthorized charging.

2. Sustainability: Integration of renewable energy sources promotes ecofriendly charging.

3. User Convenience: RFID access and real-time status display ensure a hassle-free experience.

4. Data-driven Optimization: IOT and cloud computing enable data driven insights for improved efficiency.

5. Remote Management: Centralized monitoring facilitates proactive maintenance and system upgrades.

5. CONCLUSIONS

This smart and advanced EV charging system paves the way for a sustainable and user-centric future of electric mobility. By incorporating RFID access, renewable energy integration, real-time monitoring, and a user-friendly interface, this system caters to the evolving needs of EV owners and charging station operators. As technology continues to advance, further integration of AI and machine learning can unlock even greater potential for intelligent and dynamic EV charging solutions. Additionally, Integrates the Cloud database system to store and manage customer data. This cloud-based solution enables secure storage and easy access to consumer records at any time, facilitating a smooth and automated transaction process.

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7. MAPPING OF SUSTAINABLE DEVELOPMENT GOALS

SDG 7: Affordable and Clean Energy

The use of renewable energy systems for electricity generation, helps in maintaining clean energy which is affordable at minimum cost and irrespective of location constraints.

SDG 8: Decent work and economic growth

The replacement of fossil fuels by renewable energy sources reduces the import of oil and improves countries' economic development.

SDG 9: Industry Innovation and Infrastructure

This innovative electric charging method requires the need for smart infrastructure for electric charging stations, which will boost the entrepreneurs for setting up such stations in cities and remote areas with sophisticated infrastructure.

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