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Study and Implementation of Electric Vehicle Battery Charging Station

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***Abstract*: Every person needs a system today that transfers power very effectively. One of those systems that has grown into a very busy research area in recent years is wireless power transmission. A wireless power system optimizes efficiency by lowering power loss while transferring power without the use of cables. In order to show wireless power transfer, an LED is positioned as a glowing application. The transmitting coil in this system's design connects the led to the reception coil. Power is sent through the transmitting coil to the receiver coil whenever the receiver coil is brought close to the transmitting coil, and voltage is obtained from the battery that is charged by the solar panel and transported to the power supply board. The transmitter coil is activated when RFID is swiped, and the voltage transfer is visible with the aid of an LED thanks to resonant inductive coupling. The HOMER software monitors the study of battery and solar power output.**

***Keywords*: Wireless power transfer, RFID, Homer Pro.**

1. Introduction

In order to combat rising greenhouse gas emissions and the anticipated shortage of fuel products, automakers may turn to alternative technologies like electric vehicles. However, the charging station is now a significant issue. Taking into account the owners' worries about finding an appropriate charging station, High expenses and careful planning allow us to switch to a wireless battery charger with a mix of PV power and wireless battery charger. In addition, the charging station also includes the power necessary for a specific automobile and vehicle type. This study examines the potential for using two receiver coils and contrasts it with the conventional strategy, which relies on just one receiver coil. The wireless power transmission system's novel mathematical representation serves as the foundation for this investigation. If a car is on a rechargeable road, this new model aids in determining the precise information on the ideal number of wireless coils to fully charge the vehicle. One coil is on the ground, while the other is on the car. The fixed component is referred to as the transmitter on the road. The moving receiver is the second component, which is positioned beneath the vehicle. The two components are separated by a vacuum, and each has its own electronic system. A high frequency alternating magnetic flux is produced by the transmitter block. When linked with the receiver coil, this magnetic flux is transformed into electric energy that is used to recharge the EV battery. As the next generation will set the standard for electric vehicles. Homer Pro, a microgrid optimization tool from Homer Energy, is the best hourly evaluation tool for hybrid renewable electric generation. It is the industry standard for microgrid design optimization across all sectors. The ideal size of each system component is assessed for the number of electric vehicles taken into account in a certain region. To determine the annual cost and watts needed to set up an electric charging station in our suggested model, homer pro is utilized. For instance, if we list the capacities of various devices, such as batteries, solar panels, converters, etc. It will provide an estimate of the station's overall cost, necessary PV array, and battery capacity.

2. Literature survey

This study uses wireless power transfer technology to recharge an electric vehicle's battery. Using a 555 multivibrator, the distance level between the transmitter and receiver circuit has been improved in, along with the varying power levels at various distances between the transmitter and receiver [1]. From this point forward, various current and voltage levels from the input to the output circuit for charging the battery completely took place without the use of a wire between the transmitter circuits of the charging station and the receiver circuit of the electric vehicle to determine its output efficiency. During the charging process, several out- put levels in relation to its input levels have been recorded. This empirical result helps to address a number of issues with wired technology, including charging issues, expense, wiring difficulties, and electric shocks. A technique for charging the battery from a PV array in WPT mode is suggested in [2]. The advantages of Photovoltaic (PV) arrays are utilized alongside WPT, and a method is proposed for extracting the electricity from PV arrays to charge the batteries of Electric Vehicles (EVs) using a Series-Series compensated network in WPT mode. The SS compensation network is subjected to a thorough frequency analysis, and PSIM software is used to model the proposed

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system. Electric vehicles (EVs) are becoming more and more common in today's society. There is a significant power issue in the system when EVs are charged at charging stations that are connected to the power grid. In [3] provides a charging energy solution for EVs using solar photovoltaic (PV) and biogas-based EV charging stations as two RESs. A solar PV system, two biogas engine generators, a bidirectional converter, and battery storage make up the proposed system. The variation costs, including net present cost, beginning cost, and COE, are all effective. The techno-economic and environmental viability of renewable-based EV charging systems is anticipated to benefit from this study. Discussed are the categories and problems with electric vehicles [4]. The advantages of wireless technology over wired technology were compared in [5]. In [6], the wireless power transfer standards are covered. In order to supply electricity to electric vehicles, the power can be transferred wirelessly rather than through any physical cable lines [7][8]. Review and analysis of the battery charging station are done [9]. The problem affecting the entire network is caused by the charging station's connection to the grid. Therefore, the standalone network using a variety of renewable sources uses the system with a sufficient supply of electricity [10]. Discussion and investigation of the hybrid microgrid system in residential and island areas [11].

3. Proposed Methodology

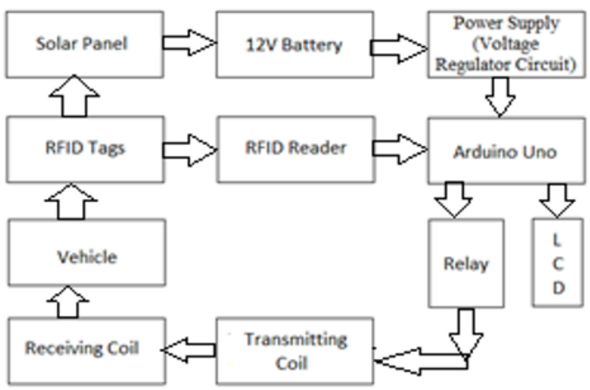

Fig 1. Block diagram of the proposed model

The proposed block diagram of a charging station is shown in Fig. 1. Photovoltaic cells, the component of solar panels, turn the solar energy of the sun into electricity. The battery is recharged by solar panels. The Arduino UNO serves as the circuit's micro controller; it receives data from the RFID reader and outputs it to an LCD display. Radio waves are utilized in this procedure to send the data from the RFID tag to the RFID reader, which is what an RFID reader is—a device that reads radio frequency identification tags. Individual RFID tags' outputs, such as battery voltage, vehicle identification number, and charging time, are presented on LCD screens. By using the inductive power transfer concept, the receiving coil attached to the car and the transmitting coil situated at the charging station will be powered. This breakthrough technology makes it possible for electric vehicles to be automatically charged without the use of charging wires. Less time will be spent producing the output, which includes battery capacity and vehicle type, and the driver will also be able to estimate how long it will take to fully charge the battery. The major goal of this research project is to:

- Implement wireless power transmission to recharge an electric vehicle's battery.
- Using the PV array's energy to charge the battery.
- To examine the output from the RFID reader provided by the Arduino Uno on the LCD display regarding the battery and vehicle types.
- To use HOMER software to assess the electrical output of the solar panels and batteries for the charging station (Solar panels with battery) situated in Benz Circle, Vijayawada.

4. HOMER Pro software

The finest hourly evaluation tool for hybrid renewable electric generation is HOMER Pro, a microgrid software from Homer Energy that is the industry standard for optimizing micro grid design in all sectors. The ideal size of each system component is assessed for the number of electric vehicles taken into account in a certain region. To determine the annual cost and wattage needed to set up an electric charging station for our project, we use Homer Pro. A simulation model is HOMER. For all conceivable configurations of the equipment, you want to take into consideration, it will try to simulate a workable system. The number of systems HOMER can simulate will depend on how you set up your challenge. In time increments ranging from one minute to one hour, HOMER simulates the operation of a hybrid microgrid over the course of an entire year.

A. Simulation Procedure

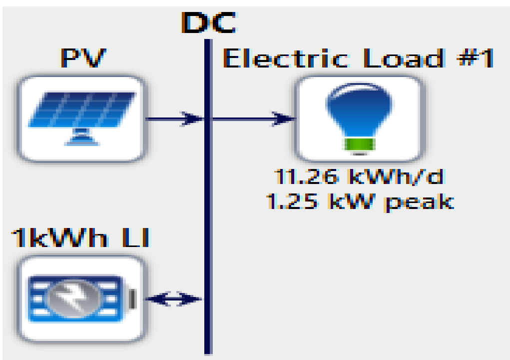

Fig. 2. Schematic diagram of proposed system and design

The fundamental requirement for the suggested EV charging station is the choice of the analyzed location. Electric load numbers are manually inputted hour-by-hour in KW for load assessment. Figure 2 shows the proposed system's schematic diagram and design. The DC bus is connected to the PV module, electric load, and battery storage. Solar photovoltaics are regarded as the system's energy source and battery for energy storage. The simulation process uses the site selection (location), load estimation (electric load values), and parametric value initialization (solar PV and battery capacity) as input terms. The specs and specifications for the basic flat-plate solar panel and the 1 KWh Li-ion battery storage system are highlighted.

B. *Location of the charging station to establish*

Fig. 3. The geographical view of the research origin (Benz Circle, Vijayawada)

The planned study project was conducted in Vijayawada, Andhra Pradesh's Benz circle. This origin's latitude and longitude values are 1629.7' N and 8039.0' E, respectively. Fig. 3 displays the geographical perspective of the research's starting point. The core place in Vijayawada is the area that we chose for the study.

5. Data Collection and Performance for Hybrid System

A variety of data are gathered for modelling solar-powered electric vehicle charging stations. Each component in the suggested system model was mathematically modelled in such a way that the output of each component was calculated in order to comprehend the performance of the hybrid system.

A. *Electric Load*

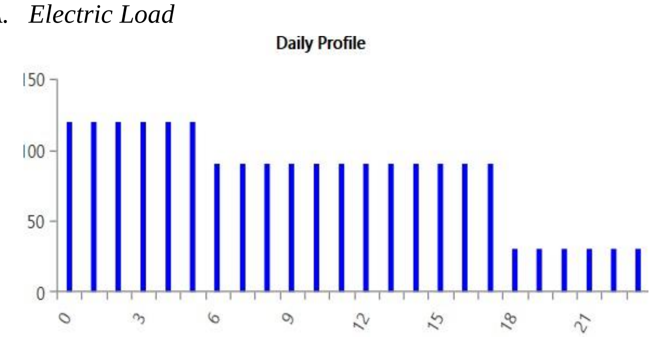

Fig. 4. A graphical representation of daily profile of the electric load of EV

According to the study's findings, the annual average energy is 11.26 kWh/d and the average power is 0.47 kW, with 1.25 kW being the peak demand and a load factor of 0.38. This performs calculations using scaled data. Fig. 4 shows a graphic representation of the daily profile of the electric load of an EV. In the HOMER page, we can change the daily profile hour by hour. Each baseline data value is multiplied by a common factor by HOMER to produce scaled data, which has an annual average value equal to the value you choose in Scaled Annual Average. The values that were previously mentioned are scaled values. Although the magnitude of the scaled data may be different, it still keeps the baseline data's structure and statistical properties. In a graph showing a seasonal profile, the electric load in KW for each and every month is indicated on the X-axis and Y-axis, respectively. HOMER automatically creates the daily profile and seasonal profile graphs based on the load data that we provided as hour-by-hour in the HOMER home page. Fig. 5 displays a graphic depiction of the seasonal profile of the electric load of an EV.

Fig. 5. A graphical representation of seasonal profile of the electric load of EV

B. *Solar GHI Resource*

The output of a flat panel PV array is calculated using the Solar Global Horizontal Irradiation (GHI) Resource. GHI is the total of ground-reflected radiation, diffuse irradiance, and beam radiation, which is also known as direct normal irradiance or DNI. Each hour of the year, or 8,760 sun radiation values, are created by HOMER. The Graham algorithm is used by HOMER to generate the synthesized values, producing a data sequence with realistic day-to-day and hour-to-hour fluctuation and auto-correlation.

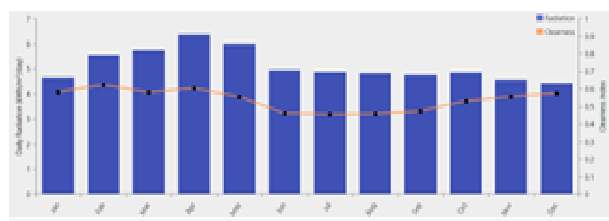

Fig. 6. Solar radiation and clearness index for selected site

The data for the monthly average solar GHI is displayed as a graph in Fig. 6. The clearness index and daily radiation (in $KWh/m^2/day$) are computed using the region provided as a place to set up the charging station. It also illustrates the clearness index, which measures the percentage of solar radiation that passes through the atmosphere.

C. *Solar and Battery Analysis*

Table 1
Detailed Specification of the utilized PV module

Parameters	Value
Rated Capacity	1000 w
Temperature Coefficient	-0.5
Operating Temperature	47°c
Efficiency	13%
Derating Factor	80%
A lifetime of the panel	20 years
Panel type	Flat plate

In the investigation, a solar PV module with a flat plate design and a 13.0 percent efficiency is used. The system keeps the nominal working cell, derating factor, and temperature coefficient at 0.5, 80%, and 47 °C, respectively. Table 1 provides a detailed specification of the PV module that was used. In the suggested method for storing the extra energy from the PV system, the battery is used as an energy storage system. a gadget that stores electricity for later use, allowing you to

Table 2
The technical and economic parametric value of the technical components

Components Name	Size	Lifetime	Capital cost	Operation & maintenance	Replacement cost
PV Module	1 KW	20 years	636.00	10	636.00
Battery	167 Ah	5 years	155.00	10	155.00

continue using appliances during a power outage and, in some situations, even save money on electricity. Table 2 displays the technical and economic parametric value of the aforementioned technological components. Table 3 provides a thorough description of the battery that was used.

Table 3
Detailed specification of the utilized battery

Parameters	Value
Nominal voltage (v)	6
Nominal capacity (KWh)	1
Nominal capacity (Ah)	167
Round trip efficiency (%)	90
Maximum charge current (A)	167
Maximum discharge current (A)	500
String size	1
Initial state of charge (%)	100.00
Minimum state of charge (%)	30.00

6. Result Obtained from Homer Software

This section presents the technical and energy analyses of the suggested PV-based EV charging system. The simulation results used in the HOMER software constitute the foundation for the investigation. A 24-hour profile of fulfilling DC primary load (EV) demand using PV and a backup battery is shown in Fig. 7. When necessary for EV operation, the battery releases energy. The blue line, which shows PV production power will be high in the afternoon due to high solar intensity, and progressively falls from 6:00PM. The load demand, which is shown in yellow hue, can be used to determine how the battery is charged and discharged. Discharging may occur if the load demand exceeds the PV output, and charging may occur if the load demand is less than the PV output.

Fig. 7. Power flow for each component in charging station for 24 hours

7. Implementation of Electric Vehicle Charging Station

As an energy source, a solar panel with a voltage of 6V and current of 100mA is used. In order to store energy in the form of chemical energy, a 12V battery needs to be charged. To maintain the voltage within the desired range, a voltage regulator circuit is also used. A power source is utilized to provide Arduino UNO, which is used as a controller, with input power. We needed the Arduino's limited range because we are using 12V batteries. As a result, we selected the Arduino Uno, a low-cost, adaptable, and simple-to-use microcontroller board with 14 digital input/output pins and 6 analogue pins with a clock speed of 16MHz that can be integrated into a range of electronic projects. The cars will have RFID (Radio frequency identification) tags attached to them, which will have all the details of the car when it arrives at the charging station. Radio waves are used to transmit data from RFID tags to RFID readers when they are scanned by RFID readers. The information about the car, such as the vehicle's battery storage capacity, the name and type of the vehicle, and the charging time for the vehicle's battery, will be displayed on an LCD screen with a 16*2 range after the RFID reader has scanned the tag. The flat panel display known as the LCD (Liquid Crystal Display) operates primarily using liquid crystals. In our project, transmitting and receiving coils are used to wirelessly charge electric vehicles. The hardware configuration of an electric vehicle charging station is shown in Fig. 8.

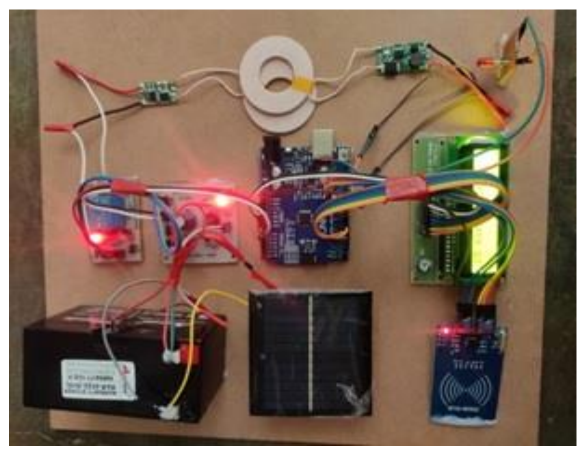

Fig. 8. Hardware setup of Electric vehicle charging station

The receiving coil will be fastened to the vehicle, while the transmitting coil will be installed in the charging station. Coils used for transmitting and receiving are separated by 2 cm. Two coils will get electrified when supply is applied, which aids in the vehicle's battery charging. This works on the inductive power transfer principle. The newest technology enables high-speed power and digital data transmission between two coils without any mechanical or electrical contact. On an LCD panel, the vehicle output will be shown.

8. Conclusion

In this study, inductive resonant coupling is used to do wireless electric vehicle charging. In this investigation, the battery is charged using a solar panel. When the vehicle runs out of power and pulls up to a charging station nearby, the vehicle is then charged using a wireless receiving and transfer coil that is placed at a specific distance from the vehicle. RFID tags that are installed inside the vehicle also estimate the charge time and type of battery. By providing battery capacity, PV capacity, and load as input data, the homer pro is used to analyze the annual cost and watts required to build up an electric charging station in the necessary location. Depending on the load demand, the battery can be charged or discharged. Discharging may occur if the PV output is greater than the load demand, and vice versa.

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