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WIRELESS ELECTRIC VEHICLE CHARGING SYSTEM USING SOLAR ENERGY

[*1]DR. Anitha N, [2]Rithika Shree S, [3]Bhavana K R

[1]Professor ECE department, Amruta Institute of Engineering and Management Sciences Bidadi Bangalore.

[2,3]Student ECE department, Amruta Institute of Engineering and Management Sciences Bidadi Bangalore.

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***Corresponding Author: DR. Anitha N**
Professor ECE department, Amruta Institute of Engineering and Management Sciences Bidadi Bangalore. DOI: https://doi-doi.org/101555/ijrpa.3961

ABSTRACT

The rapid growth of electric vehicles (EVs) has increased the demand for sustainable and convenient charging solutions. Conventional plug-in charging methods face challenges such as dependency on grid electricity, limited charging infrastructure, and user inconvenience. To address these issues, this project proposes a solar-powered wireless electric vehicle charging system that integrates renewable energy with modern power transfer technology. The system utilizes photovoltaic (PV) panels to harness solar energy, which is then conditioned using maximum power point tracking (MPPT) and stored in a battery or directly supplied to the wireless charging unit. Wireless power transfer (WPT) based on inductive coupling enables efficient and contactless energy delivery from the ground-based transmitter coil to the receiver coil installed in the vehicle. This eliminates the need for physical connectors, reducing wear and improving user convenience. The proposed design enhances the sustainability of EV charging by leveraging clean solar energy, while also offering flexibility, safety, and ease of use. Such a system can significantly contribute to reducing greenhouse gas emissions, supporting smart grid integration, and accelerating the adoption ofeco-friendly transportation

INTRODUCTION

The rapid rise of electric vehicles (EVs) has increased the need for charging systems that are efficient, sustainable, and easy to use. Conventional plug-in chargers face drawbacks such as physical wear, connector inconvenience, and dependence on grid electricity, which is often generated from non-renewable sources. To overcome these limitations, solar energy integration and wireless power transfer (WPT) have emerged as promising alternatives. A Solar Wireless Electric Vehicle Charging System combines clean solar power with the convenience of wireless charging. Solar panels harvest renewable energy and supply it directly—or via battery storage—to a wireless charging unit. Using inductive coupling, a transmitter coil embedded in the ground transfers power to a receiver coil mounted on the EV, eliminating the need for physical cables.

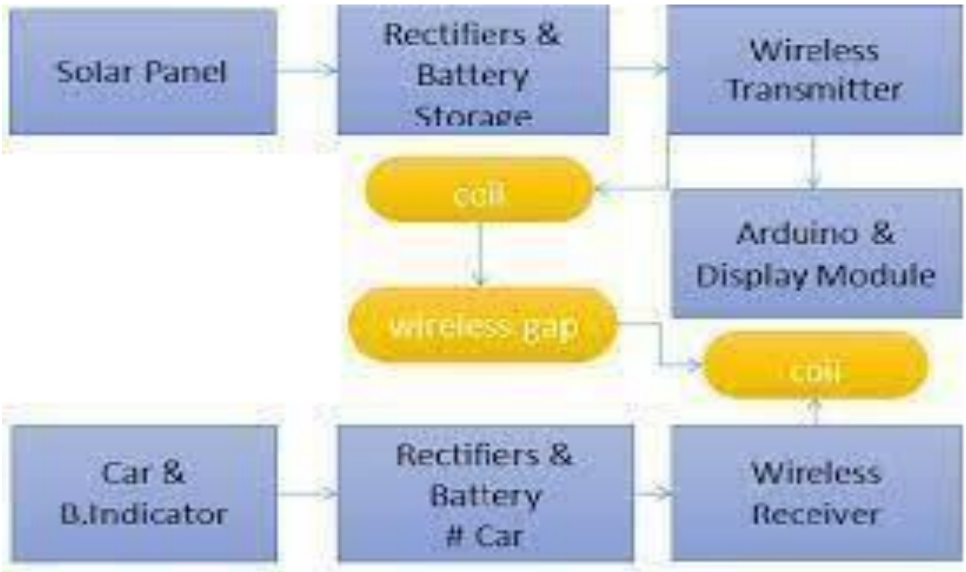
2. Problem Statement and Literature Review

The rapid growth of electric vehicles has intensified research on improving charging technologies, as traditional plug-in systems suffer from connector wear, user inconvenience, safety risks, and reliance on grid electricity derived from non-renewable sources. Studies on Wireless Power Transfer (WPT), particularly inductive and resonant inductive coupling, show promising efficiency and usability improvements, while advancements in solar photovoltaic systems offer clean and reliable energy for EV charging. Recent work integrating solar power with WPT highlights the potential for cable-free, eco-friendly charging; however, challenges persist in alignment accuracy, efficiency optimization, and cost reduction. These limitations create the need for a low-cost, sustainable, and user-friendly charging solution that reduces grid dependency and eliminates physical connectors. Therefore, this project focuses on developing a solar-powered wireless EV charging system that is efficient, reliable, and suitable for practical deployment, supporting greener and more convenient electric mobility.

3. Working Principle

The wireless electric vehicle charging system using solar energy operates by converting sunlight into electrical power and transferring this power wirelessly to the vehicle's battery. Solar photovoltaic (PV) panels capture solar radiation and convert it into DC electricity, which is then regulated and stored in a battery or supplied directly to the wireless charging circuit. The charging unit uses inductive coupling, where a high-frequency AC signal is fed to a transmitter coil embedded in the ground or charging pad. This creates an oscillating magnetic field around the coil. When the vehicle is parked above the pad, a receiver coil mounted on the underside of the EV intercepts the magnetic field, inducing an AC voltage through electromagnetic induction. This induced voltage is rectified and regulated into DC power, which charges the EV battery. The system achieves safe, cable-free power transfer, with alignment and control circuits ensuring efficient energy delivery while preventing overcharging or energy loss. By combining renewable solar energy with wireless power transfer, the system provides a clean, convenient, and automated method for EV charging.

4. Methodology



1. Solar Panel (PV Array)

   Captures sunlight and converts it into DC electricity.
2. Charge Controller

   Regulates the solar output to protect batteries and ensure stable power flow.
3. Rectifier &Battery Storage

   Stores excess solar energy for use during night-time or cloudy conditions.
4. Arduino and Display Module

   Arduino is an open-source microcontroller platform used for building Electronics project
5. Wireless Transmitter

   Generates an alternating magnetic field when powered, placed on the ground or charging pad.
6. Wireless Receiver

   Mounted on the EV, it receives energy through inductive coupling from the transmitter coil.
7. Car and Indicator

   The final stage where DC power is stored, charging the EV for operation.

5. RESULT

The developed solar-based wireless EV charging system successfully demonstrated efficient, cable-free power transfer using inductive coupling. The solar photovoltaic module provided a stable renewable energy source, and the regulated output was effectively used to drive the wireless transmitter coil. Experimental testing showed that the receiver coil on the vehicle was able to harvest sufficient power for battery charging when positioned within the designed alignment range. The system achieved consistent energy transfer with minimal losses under optimal coil alignment, confirming the feasibility of integrating solar generation with wireless power transfer. The prototype also validated safe operation, electrical isolation, and reduced dependency on grid power. Overall, the results indicate that solar-assisted wireless charging can serve as a reliable, eco-friendly, and convenient alternative to conventional plug-in EV charging

6. CONCLUSION

The integration of solar energy with wireless power transfer offers a promising solution to the limitations of conventional EV charging systems. By combining clean photovoltaic generation with inductive charging technology, the system eliminates the need for physical connectors, enhances user convenience, and reduces dependency on grid electricity. Experimental findings confirm that the proposed setup can deliver reliable, safe, and environmentally sustainable power to electric vehicles within practical alignment conditions. Although further optimization is needed to improve efficiency and scalability, the results demonstrate that solar-based wireless charging is a viable and forward-looking approach for supporting the growing demand for green mobility. This technology has strong potential to shape future EV infrastructure by enabling more accessible, automated, and eco-friendly charging

Applications

Sustainability & Renewable Integration

- Reduction of EV charging dependency on the grid by harnessing renewable solar energy.
- Contribution towards carbon footprint reduction in the transport and energy sectors.
- Scalability & Smart Grid Compatibility

  Insights into integration with smart grid and Vehicle-To-Grid (V2G) technologies.
- Potential for deployment in urban infrastructure, highway, parking lots.

- Economics Viability Assessments
- Cost benefit analysis comparing solar wireless charging with conventional charging station.
- Identification of conditions under which large scale adoption is feasible
  Research Contributions
- Novel methodology for improving wireless power transfer (WPT) efficiency using renewable source.

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