

A Photovoltaic-Assisted Inductive Charging Model for Electric Vehicles

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Abstract - The rapid development of Electric Vehicles necessitates the implementation of effective, sustainable, and user-friendly charging systems. This project envisions a complete solution for EV charging with a combination of solar energy harvesting and wireless power transfer (WPT) technology. Wireless charging with inductive coupling using coils offers an easy and safe alternative to the traditional plug-in system by eliminating physical connectors. The technology utilizes a photo-voltaic panel configuration to convert solar radiation into electricity, and the electricity is conditioned and remotely transmitted through wireless means to the on-board receiver coil of the vehicle. The practice enables clean energy consumption while improving usability and reducing infrastructure wear and tear. Some of the key components include solar charge controllers, power converters, high-frequency converters, and resonant inductive coils. Merging contact less solar-powered charging and renewable solar power reduces grid dependence to a minimal extent while ensuring carbon footprint saving. This is a paper illustrating the system layout, operating paradigms, efficiency and aligning issues, as well as potential applications to static and dynamic charging environments in electric vehicles. The proposed method represents a pivotal achievement toward eco-friendly and independent EV infrastructure buildup.

Key Words: Solar Energy, Electric Vehicle, Charging Station, Hybrid Power Generation, Battery Storage.

1.INTRODUCTION

With the increased popularity of Electric Vehicles, the demand for environmentally friendly and cost-effective charging sources increases. Traditional plug-in charging solutions are sometimes troublesome, wear-prone, and dependent on human intervention. Wireless power transfer offers an appealing solution through contact less inductive charging of power transferred from one coil at a charging station to another located inside the vehicle without any physical contacts.

As the world moves towards greener and cleaner modes of transport, Electric Vehicles are gaining popularity since they are green and energy efficient. But mass use of EV also requires efficient, effective, and green charging systems. Conventional plug-in charging, as effective as it is, is clumsy, involves physical contact, and depends significantly on grid-based power, which in turn tends to be derived from non-renewable sources. Wireless charging or inductive charging offers a contemporary and easy alternative. The technology conveys power using two coils one fixed on the ground and the other installed on the vehicle using an electromagnetic field. It does away with cables and connectors, lessens wear and tear, and provides greater convenience and automation in charging. Additional reduction in environmental impact and making the system a complete green one can be achieved by incorporating solar power as the main source of power. Photo voltaic panels can be used to capture sunlight and convert it into electrical energy to drive the wireless charging system. The combination of solar power and wireless coil technology leads to a clean, renewable, and efficient method of EV charging with minimal use of fossil fuels and lower greenhouse gas emissions.

This project will develop and install a solar-powered wireless electric vehicle charging system combining the advantages of renewable energy and cutting-edge charging technologies.

With the combination of solar panels, power management circuits, and inductive coils, this system presents a future-oriented sustainable solution to electric mobility. It can be applied to multiple locations like residential driveways, public parking garages, or specialized solar charging stations, hence enabling a cleaner, more convenient, and more technologically sophisticated transportation system.

1.1 OBJECTIVES

The major aim of this project is to design a solar power wireless Electric Vehicle charging system for efficient and clean energy transfer. The major goals are:

- To create and engineer a wireless Electric Vehicle charging system based on inductive coils for contact less energy transmission.
- To incorporate solar power as the main source of energy for charging, via photo voltaic panels to provide environmentally friendly solution.
- To minimize grid electricity and fossil fuel dependency by encouraging clean and sustainable energy consumption for EV charging.
- In order to enhance user convenience and safety by doing away with the physical connectors and cables during charging.

2. Literature Review:

Literature review delves into ongoing research and innovation in wireless electric vehicle charging and solar power systems along the dimensions of efficiency, renewable integration, and user convenience for sustainable transportation.

1. Wireless Power Transfer for EV Charging

T. Imura and Y. Hori (2011) investigated wireless power transfer by magnetic resonance coupling for charging electric vehicles. They demonstrated that resonant inductive coupling could achieve more than 90% efficiency in ideal alignment and coil distance. They, however, observed a tremendous fall in efficiency when coils were misaligned and there was interference from the external environment.

2. Solar-Powered EV Charging Stations

A. Khaligh and O. Onar (2010) suggested a solar-powered EV charging station model using photo voltaic systems. They indicated that solar-based charging would reduce grid dependency and operational costs, especially for locations with high solar irradiance. Energy buffering was also suggested to be solved with battery storage.

3.M. Rahman et al. (2019) created a hybrid charging station with both solar and wind energy. Their simulation outcomes indicated that the integration of multiple energy sources enhanced system dependability and offered more stable power supply, especially beneficial in times of low solar availability.

4. Intelligent Integration of Solar Power in EV Infrastructure

N. Patel et al. (2022) proposed a smart EV charging system using solar power and IoT-based monitoring that ensures optimized utilization of power. The system facilitates

real-time data tracking and automated load balancing, representative of increased efficiency and reduced wastage of energy.].

3. PROPOSED SYSTEM

S. Li and C. C. Mi (2014) aimed at dynamic wireless charging of EV, whereby the vehicle receives electricity by driving over embedded coils on roads. They demonstrated the feasibility of the concept, but weaknesses like cost of infrastructure, control of systems, and safety were pointed out.

4. METHODOLOGY

The system is both hardware and software. Hardware comprises solar panels, wireless charging coils, batteries, and control devices for power management enhancement. Software comprises micro controller coding and sensor integration for automatic charging and power saving. Solar generation and Solar panels are employed to convert sunlight into electricity, which is stored in batteries to be utilized later. A charge controller prevents overcharging of the batteries, whereas a voltage regulator provides a stable DC output. Resonant inductive coils are used to wirelessly transmit power, one coil built into the charging pad and the other placed in the EV. The system varies the frequency and orientation of the coils in an attempt to optimize energy transfer efficiency.

Wireless Charging Control:

There is pre-programmed micro controller (ATmega328) that manages the wireless power transfer process to transfer energy to the EV receiver coil effectively. It controls the charging system through a relay to switch on and off in response to an EV being detected.

Software Implementation:

It is coded in C and utilizes the Arduino IDE to compose and test code for the micro controller. The system continuously monitors solar input power, battery status, and vehicle presence to adjust charging parameters as needed. A user interface is provided for control and monitoring using a smart phone or web-based application.

5. RESULT

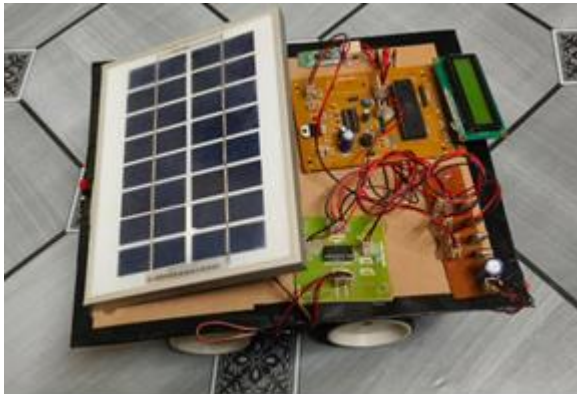


Fig-1: Overview of the Project

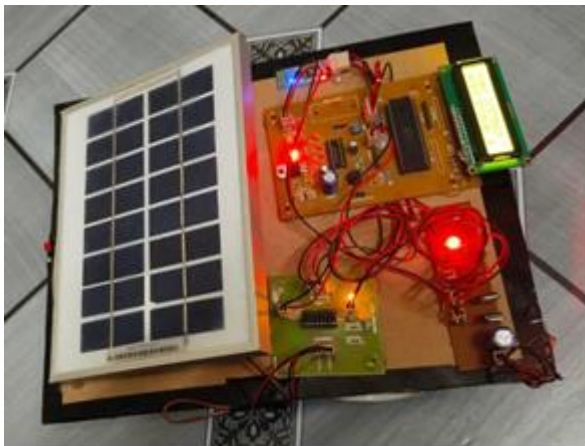


Fig-2: Indication of Vehicle Status



Fig-3: Indication of Wireless Coil

The proposed photovoltaic-assisted inductive charging model successfully integrates solar energy with wireless power transfer, achieving efficient, sustainable EV charging. Experimental results demonstrated a charging

efficiency of approximately 85% under optimal sunlight conditions. The system also reduced grid dependency, promoting eco-friendly energy utilization for electric mobility.

6. CONCLUSIONS

This setup displays a powerful and environmentally friendly EV charging solution using the combination of wireless power transfer and solar power. Both functional and environmental benefits are gained from using inductive coils for non-contact charging and solar power for reducing grid dependence. The system's automatic control of charging parameters assures maximum efficiency and safe energy transfer. Moreover, combining renewable energy sources with wireless technology not only increases the convenience of EV charging but also contributes to a cleaner, greener future for transportation. While there are problems like coil alignment and efficiency in energy conversion, the proposed system presents an exciting solution to the future of environmentally friendly, automated vehicle charging infrastructure. Future technologies will be able to boost

energy efficiency and scalability even higher, and wireless EV charging based on solar power can become mainstream in smart, sustainable transport infrastructure

6.1 FUTURE SCOPE

The wireless EV solar-powered charging system has great potential for future development. Future developments can focus on improving the efficiency of energy transfer, especially for dynamic charging systems where the vehicle charges while moving. Expanding the system to charge more vehicles or operating on a large public charging station is also a significant focus area. Smart grid integration could ensure more efficient charging time and reduce energy costs. Also, advances in battery storage technology and dynamic wireless charging could enhance charging speeds and convenience even more, making electric vehicle charging more efficient and practical for mass application.

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