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# Design And Implementation Of Hybrid Powered Wireless Lane Charging Station For Electric Vehicles

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***Abstract:*** The transition towards sustainable transportation has necessitated the development of efficient and eco-friendly electric vehicle (EV) charging infrastructure. Conventional plug-in charging methods suffer from long charging times, reliance on grid power, and operational inefficiencies. To address these challenges, this research presents an innovative hybrid-powered wireless lane charging station, integrating solar and wind energy sources with Dynamic Wireless Power Transfer (DWPT) technology to enable continuous, in-motion charging of EVs. A dual-input, single-output DC-DC chopper circuit is designed to efficiently regulate and combine power from renewable sources, ensuring a stable DC power supply for wireless energy transfer. Simulation and prototype testing results demonstrate that the hybrid-powered system effectively delivers consistent energy to moving electric vehicles, enhances energy utilization and reduces grid dependency. The integration of green energy sources into wireless charging infrastructure paves the way for a sustainable, efficient and intelligent transportation ecosystem.

***Keywords****: DC-DC Chopper, Dynamic Charging, Electric Vehicles, Hybrid Renewable Energy, Super capacitors, Wireless Power Transfer.*

## I. INTRODUCTION

The global push toward sustainable transportation has driven significant growth in the electric vehicle (EV) market. According to the International Energy Agency (IEA), the number of electric cars on the road surpassed 10 million in 2020, and this trend continues to accelerate [1]. While EVs offer a cleaner alternative to internal combustion engine vehicles, their widespread adoption is hindered by challenges such as limited battery capacity, long charging times, and the sparse distribution of charging infrastructure [2], [3].

Wireless power transfer (WPT) technology has emerged as a game-changing solution to these limitations. Unlike traditional plug-in methods, WPT enables contactless energy transfer using magnetic fields, which can be integrated into roadways for continuous charging of EVs while in motion—a concept known as dynamic wireless power transfer (DWPT) [4]. DWPT helps eliminate range anxiety and reduces the need for large, heavy batteries, thereby enhancing vehicle efficiency and extending battery life [5].

However, a critical aspect of implementing WPT systems at scale is the source of the electrical energy. Relying solely on the grid may exacerbate carbon emissions, particularly if the grid is not predominantly renewable. Therefore, the integration of hybrid renewable energy systems (HRES) is essential to provide a clean, resilient, and self-sufficient energy supply. Hybrid systems combining photovoltaic (PV) solar panels, wind turbines, and grid backup offer improved reliability and operational flexibility in varying environmental conditions [6], [7].

Recent studies have explored the integration of solar and wind energy for powering EV charging stations, showing that such systems can significantly reduce operational costs and environmental impact [8], [9]. However, few implementations address the complexities of powering dynamic lane charging infrastructures using hybrid sources. These systems require careful coordination of energy generation, storage, and wireless transmission to ensure continuous power delivery and system stability.

This paper presents a comprehensive design and implementation of a hybrid-powered wireless lane charging station for EVs. The system integrates PV panels and vertical-axis wind turbines (VAWTs) as primary energy sources, supplemented by battery storage and intelligent energy management. The WPT system employs resonant inductive coupling to maximize transmission efficiency and minimize power losses.

## II. PROPOSED SYSTEM

The integration of wireless power transfer (WPT) technology in electric vehicle (EV) infrastructure has been the subject of extensive research over the past decade. Early WPT systems focused on static charging, where vehicles remain stationary over a charging pad. In a high-efficiency inductive charging system was developed for stationary EVs, achieving over 90% efficiency through resonant inductive coupling. However, such systems are limited by vehicle downtime and the inconvenience of fixed charging locations.

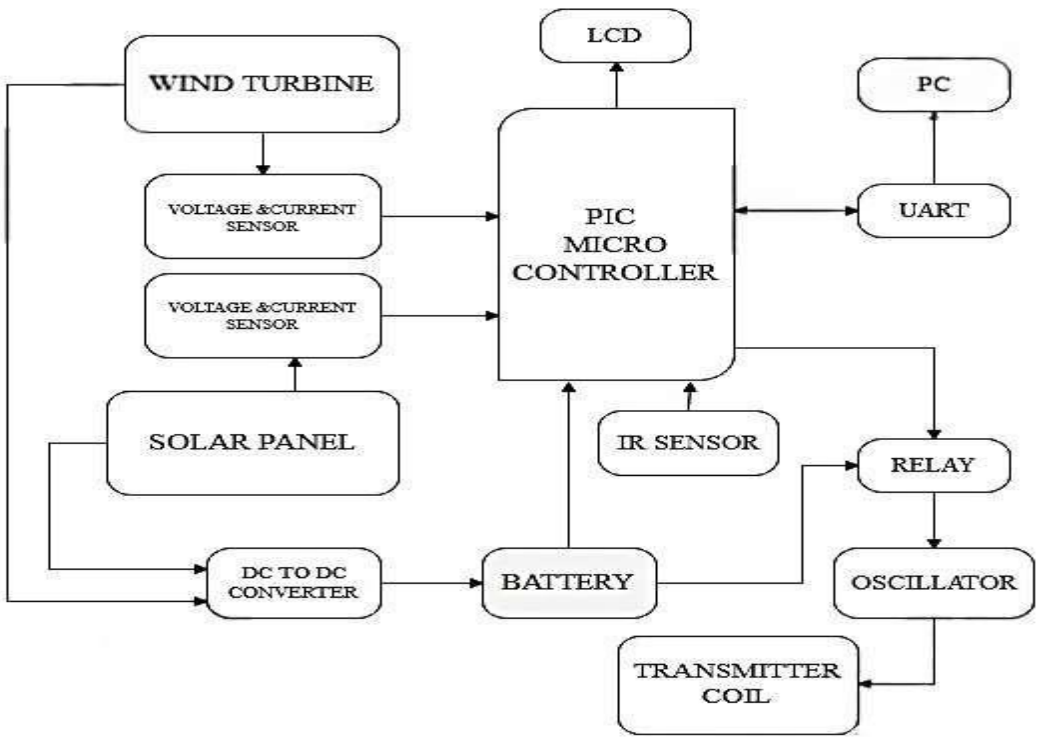


**Figure 1 : Block Diagram Of Proposed System In Transmitter Side**

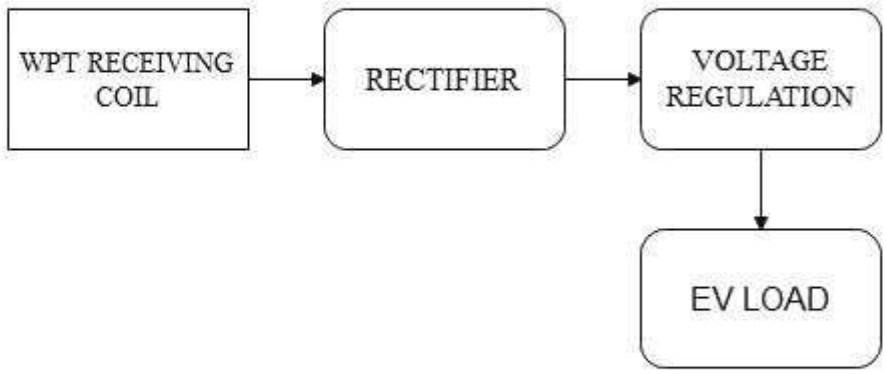


**Figure 2 : Block Diagram Of Proposed System In Receiving Side**

To address these limitations, dynamic wireless power transfer (DWPT) systems were introduced. The work in outlines the fundamental principles and design considerations of DWPT systems, including alignment challenges, magnetic field interference, and real-time power control. In a segmented primary coil design was proposed to enhance energy efficiency and reduce electromagnetic interference, demonstrating significant improvements in transmission performance for in-motion charging. Energy sustainability is another critical factor in WPT deployment. In a hybrid solar-wind powered charging station was designed, demonstrating the feasibility of using decentralized renewable sources for EV charging in off-grid regions. Energy sustainability is another critical factor in WPT deployment. Several studies have investigated the use of renewable energy sources to power EV charging infrastructure. A hybrid solar-wind powered charging station was designed, demonstrating the feasibility of using decentralized renewable sources for EV charging in off-grid regions. Despite these advances, few studies have implemented a complete prototype combining DWPT, hybrid renewable energy sources, and intelligent energy management in a single system. Moreover, environmental durability, power reliability under fluctuating conditions, and real-time performance optimization remain underexplored. This paper addresses these gaps by presenting a fully functional hybrid-powered wireless lane charging system, validated through practical deployment and empirical evaluation

## III. EXPERIMENTAL SETUP

To implement the proposed system practically, an experimental hardware prototype was developed using real-time interfacing components. The setup is based on the AT89S52 microcontroller, integrated with sensors, a relay driver circuit, a wireless power transfer (WPT) module, and a rechargeable battery. Fig. 3 shows the assembled hardware kit.

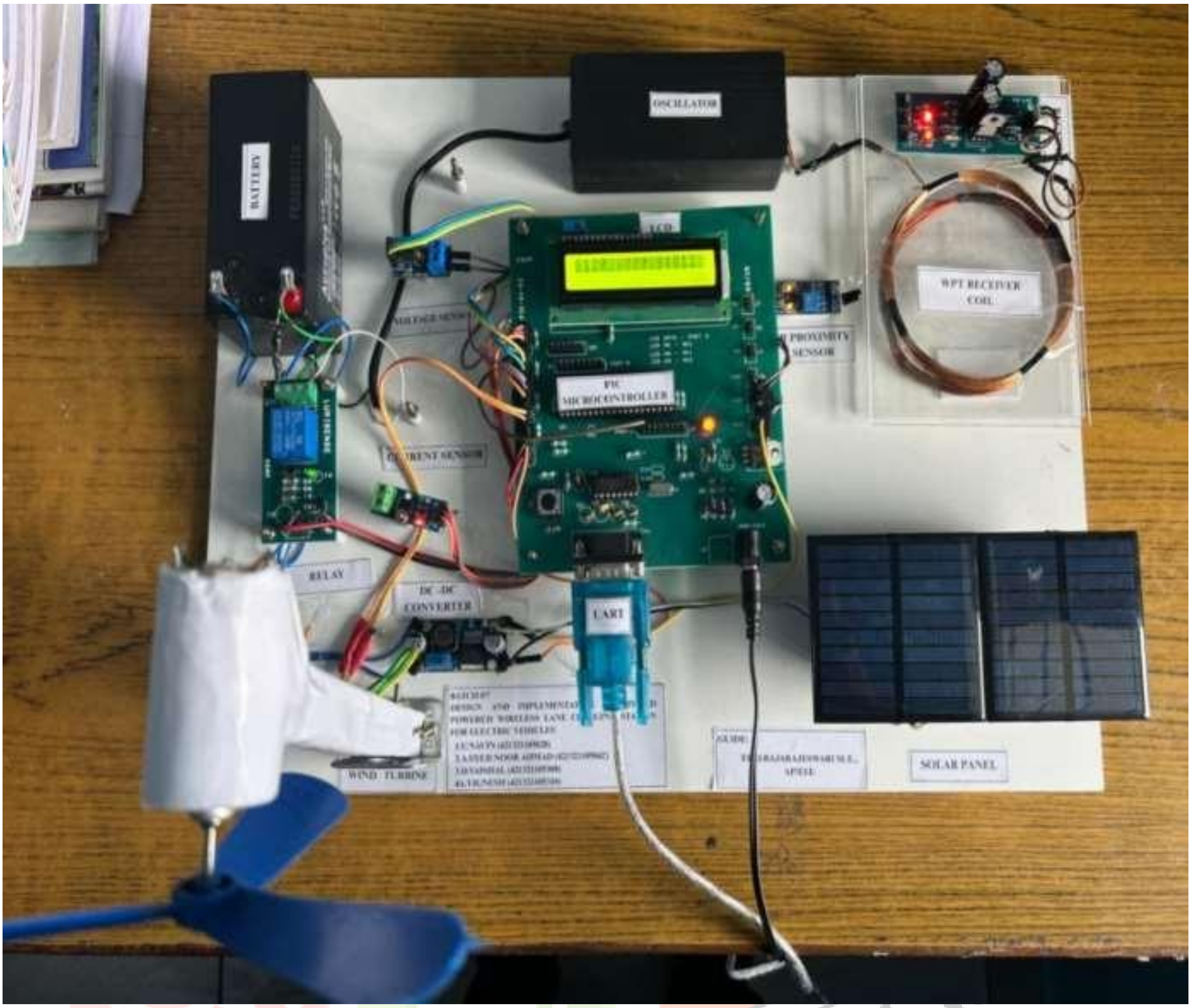


**Figure 3 Hardware arrangement**

The core of the system, mounted on a general-purpose development board with support for serial communication via UART. Voltage and current sensors (opto-isolator-based) are connected to monitor real-time input from renewable sources. A 5V relay controlled by a ULN2001A driver circuit switches between WPT and direct battery charging. Power supply includes a battery backup unit and a DC step-down converter module for regulated voltage supply. USB-to-serial converter enables communication with Arduino IDE to monitor and log output values during testing.

## IV. EXPERIMENTAL RESULTS AND DELIBERATIONS

Currently, the output of the microcontroller is being validated using the Arduino IDE Serial Monitor via UART communication. Real-time data such as voltage level, current flow, relay status, and energy source switching logic are displayed for debugging and validation purposes.


**Figure 4 : Serial Plotter 1**

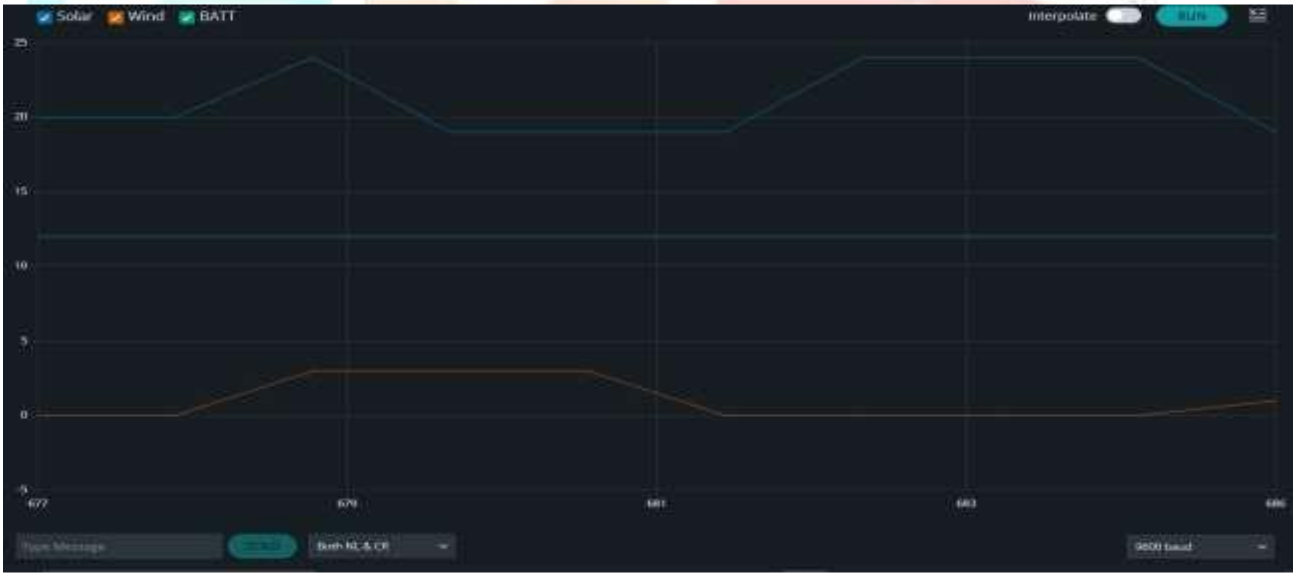


**Figure 5 : Serial Plotter 2**

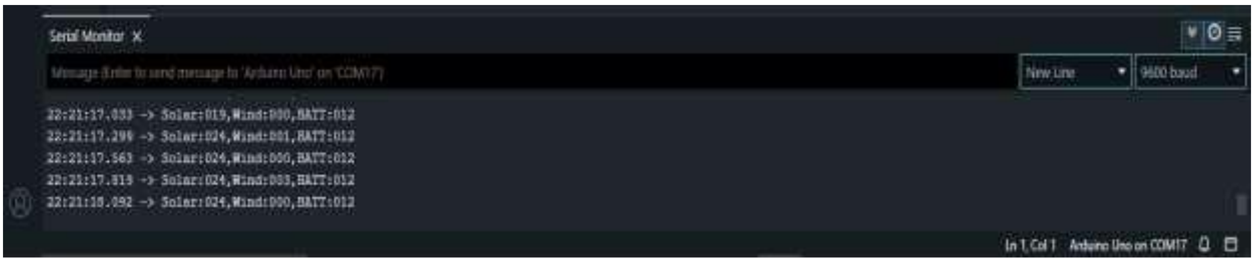


**Figure 6 : Serial Monitor**

## V. CONCLUSIONS

The development of a hybrid-powered wireless charging station presents a sustainable and efficient solution for the modern EV charging infrastructure. By integrating renewable energy sources with wireless charging technology, the system eliminates major challenges faced by conventional plug-in charging stations, including grid dependency, long waiting times, and energy inefficiencies. This research paves the way for a greener, more efficient, and autonomous EV charging ecosystem, contributing to a sustainable transportation future.

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