

# Solar Wireless Charging System for Electric Vehicles

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**Abstract—** Cable-free Wireless Power Transfer (WPT) of electric vehicles using electromagnetic fields, offering convenience, efficiency, and automation. Utilizing resonant inductive coupling, it optimizes energy transfer, reduces losses, and ensures safety with features like foreign object detection. A proposed system combines transformer induction and adaptive robotics for efficient charging, achieving a unity power factor over an 8 cm air gap, a 10 cm sliding range, and producing 15V via solar energy. Scalable and adaptable, WPT supports deployment in various locations, promotes EV adoption, and ensures compatibility with evolving EV standards. Continued research is vital for improving efficiency and charging speed.

**Keywords—** WPT, EVs, Resonant Inductive Coupling, Transformer Induction, Adaptive Robotics.

## INTRODUCTION

Electric vehicle (EV) charging through wireless power transfer (WPT) is one new technology offering an interesting answer to issues involving draw-in chargers. Traditionally, wires and connections make charging less than favourable, while limiting the access and mobility. WPT technique provides many edges over regular mechanisms of transferring power, explaining why it's gained popularity of late.

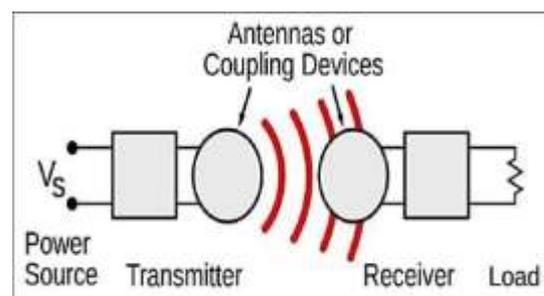
From low-power biomedical implants to electrical vehicle plates and road cars with efficiencies in excess of 95 or two in some prototype systems, it has been put forward to operate in a wide range of applications. To transfer electric power from two or more magnetically coupled coils over a large air gap, WPT systems rely on strong field coupling.

### A. Wireless Power Transfer

Electric power can now be transmitted wirelessly using

a technology called wireless power transfer (WPT), which uses electromagnetic fields instead of cables. It is used where conventional wiring becomes unsafe, e.g., medical implants, electric vehicles, and off-grid power supplies. Two types of WPT exist: nearfield and farfield. Inductive coupling, a type of near-field technology, is widely applied to the wireless charging of portable devices, RFID tags, and implantable devices like pacemakers. Remote energy-transfer technologies include power beaming, which utilizes microwaves or lasers and makes possible long-distance energy transfer. These technologies serve well in applications like solar power satellites and wirelessly powered unmanned vehicles. The main advantages of WPT can be enumerated as the removal of physical connectors, reduced wear and tear, and charging in locations otherwise unattainable.

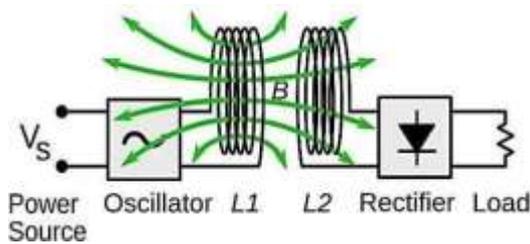
It is particularly valuable in healthcare and ordinary electronic devices. There remain a few issues to resolve including the inefficiency with greater distance and safety concerns with high-power radiation exposure. The enhancement of WPT efficiency, extended range, and new applications like large-scale electric vehicle charging are under investigation. With technology progression, it can influence energy transmission in other industries.



The field is radiated into space and picked up by single or multiple receivers, which again convert the field into useful electric current to energize an electrical load. The transmitter uses a device like a coil, metal plate, radio wave antenna, or laser to generate the electromagnetic field. A device of the same kind at the receiver picks up the field and converts it to electricity. Oscillation frequency (in hertz) sets the wavelength and defines the mode through which energy travels through the gap.

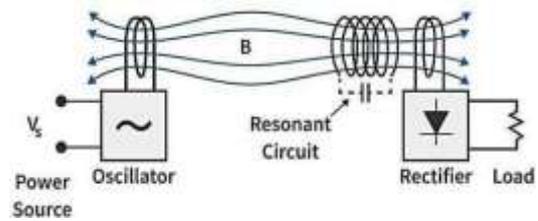
**Near field(non-radiative) methods**

Near-field (non-radiative) techniques are power-based electric and magnetic field transmission, which is reduced with the cube of the distance. They are quasi-static oscillating dipole fields and the efficiency of power transfer decreases by a significant amount with an increase in distance. In inductive coupling, power is transmitted between two coils by a magnetic field caused by an alternating current (AC) in the transmit coil. The magnetic field thus produces an alternating voltage on the receiver coil a flow that powers the load. Chargers for electric toothbrushes are examples of such because they operate in 50/60 Hz AC, but other increased modern arrangements employ increased frequent AC from an oscillator to function effectively. The passing of maximum power can be attained if coils are mounted along the longitudinal side, whereas in radiative systems coils are mounted in transverse. Induction coupling is best explained as appropriate for near-distance power transmission, several times the size of the antenna.



**Fig 1.2 Inductive Wireless Power System**

Resonant magnetic coupling is the term we have to invariably apply in indicating power transfer through a magnetic field from a transmitter to a receiver. Both transmitter and receiver must consist of resonant circuits. The two circuits are either a coil with a capacitor or a self-resonant coil. With these two circuits, coupled together, the resonance at the same frequency improves coupling and power transfer. In the same manner, a vibrating tuning fork can, by an inductive process, in other words, induce vibrations into a second fork so long as the two forks are tuned to the same frequency. Coupling through resonance is stronger and wider in range than coupling through usual inductive coupling, which does not aim at resonance.



**Fig 1.3 Resonant Inductive Wireless Power System**

Capacitive coupling, or electrostatic induction, is the transmission of electrical power by fields between electrodes, that is, metal plates, to form a capacitor.

The insulating material forum that prevails allying the plates influences an alternating voltage to be implemented to the transmitter plate so that a time-varying electric field produces a time-varying potential at the receiver plate, resulting in an alternating current in the load circuit. The power transmitted depends on the frequency, the voltage, the capacitance between plates, and plate size, and decreases if the space between the plates is reduced.

**LITERATURE REVIEW**

The integration of solar energy with wireless electric vehicle (EV) charging systems has become a significant area of research, aiming to develop sustainable, contactless, and efficient energy transfer mechanisms. This literature review highlights the evolution, methodologies, and technological innovations in this field, drawing from recent and foundational studies.

Kashani et al. [1] provide a state-of-the-art review of wireless charging technologies integrated with solar power, emphasizing resonant inductive coupling, photovoltaic (PV) integration, and power electronics. Their comprehensive assessment outlines the challenges in power density, alignment issues, and energy conversion efficiency, establishing a roadmap for future research. Sudake et al. [2] focus on a practical implementation of a solar-based wireless charging system. Their study details the design of an efficient wireless charging prototype utilizing a PV array, demonstrating moderate efficiency under controlled conditions. They underscore the necessity of system optimization under varying solar intensities. In a similar context, Nethra et al. [3] extend the application of wireless charging by integrating hybrid renewable sources—solar and wind. Through MATLAB-based simulations, their model investigates energy management algorithms and load balancing, indicating that hybrid systems offer increased reliability for off-grid EV charging.

Suresh et al. [4] explore a roadside solar wireless charging station, combining PV technology with inductive power transfer (IPT). Their work emphasizes scalability and modularity, suggesting that such infrastructure could support on-road dynamic charging systems to address range anxiety in EVs. Khan et al. [5] present a comprehensive review of solar-powered EV charging technologies, covering architectural configurations, control strategies, and economic considerations. This foundational work identifies grid dependency and energy storage as key bottlenecks and advocates for smart grid integration and efficient battery management systems.

Karim et al. [6] propose a wireless solar charging framework as part of a doctoral dissertation, addressing real-time charging control, wireless energy transfer protocols, and environmental adaptability. Their simulation results indicate that multi-coil systems enhance energy transfer efficiency, especially in urban deployment. Yap et al. [7] broaden the scope by reviewing solar-powered charging stations for battery electric vehicles. They discuss stationary and mobile infrastructure, policy frameworks, and life-cycle assessments, concluding that long-term viability depends on urban planning and financial incentives for renewable deployment. Finally, Kandasamy et al. [8] focus on on-road dynamic charging, where solar energy harvested roadside powers EVs in motion via wireless charging pads. This futuristic model presents a scalable and uninterrupted power solution, though it raises questions around infrastructure costs, vehicle compatibility, and electromagnetic interference.

## II. METHODOLOGY

The organisation in reference is a wireless power supply for electric vehicles via an inductive charging system powered by solar energy that functions whenever a vehicle is moving. The techniques involved in the combination of solar energy, high-frequency inductive coils, power management circuits, and an Arduino microcontroller for effective transfer and management of power. In addition to regulating power transfer, it works with the motor driver circuit for the electric vehicle. This way, it will manage the function of the two motors so that they may run effectively according to the charge left in the battery. Further, the microcontroller will regulate the vehicle speed and power consumption considering the energy being supplied by the inductive charging system

### *Solar Energy Harvesting and Storage*

The solar panel system is installed to capture sunlight. DC power will be generated from solar energy and stored in the battery. This battery is an essential factor that constitutes an unbroken power supply for the subsequent inductive charging. The battery is always charged and feeds energy into the inductive primary coil even during dull sunlight periods. Next, a solar panel is charged to the battery, supplying the charging and storage required.

### *Power Conversion and Inverter Circuit*

Normally, the battery stores power in the form of direct current (DC). Induction charging calls for this DC to be transformed to alternate current (AC) to enable wireless power transfer. In simple terms, the inverter converts DC into AC. The inverter circuits convert the direct current (DC) output from the battery to the high AC frequency that is necessary to generate the electromagnetic fields required for inductive charging. The directly converted AC energy is fed into the primary coil lying underneath the road.

### *Inductive Coupling via High-Frequency Coils*

System scalability and environmental impact This methodology provides for the use of renewable solar energy to offset the dependence on fossil fuels and thus reduce GHG emissions. The provision for more primary coils on road segments would enable the wider spread of electric vehicles, powering charging for extended journeys and minimizing the necessity for extreme recharging.

### *Energy Reception and Conversion in the Vehicle*

When the vehicle's receiver coil enters the range of the magnetic field, it captures the induced AC power. The AC is rectified within the vehicle, after which the DC voltage thus produced is connected back to charge the EV battery, which is regulated to ensure that the battery constantly receives a standard voltage.

### *Power Management via Arduino Microcontroller*

The brain of the Entire arrangement is Arduino, which controls the power transfer process. The microcontroller limit the inverter's operation and switching of power to the primary coil. Moreover, it is constantly monitoring the battery states of both the EV and solar battery storage and supervising energy management. The microcontroller also regulates the power supplied to the receiver coil based on the alignment of the coils and speed.

### *Motor Driver and Vehicle Propulsion Control*

In addition to power management, the Arduino is employed to control the motor driver circuit of the whole shop. This side-by-side drive control in the motor ensures that the vehicle operates following the efficient use of battery charge. The microcontroller feeds a power supply into a motor and keeps the quantity of movement of electric charge sufficient to keep it moving.

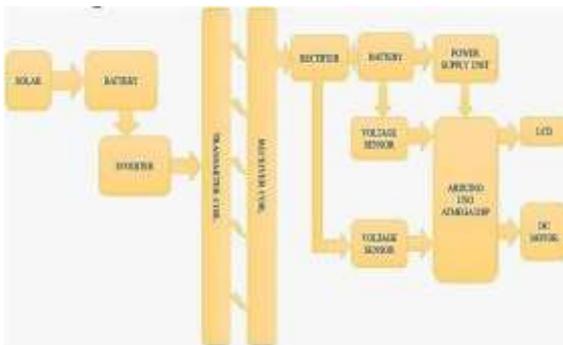
### *Charging Continuity and System Optimization*

One of the main advantages of this system is that the vehicle is continually charged while moving over road segments with embedded primary coils. To ensure

continuous and efficient charging, the primary and receiver coils must be precisely aligned, and the strength of the magnetic field must be optimized. The frequency of the magnetic field and the design of both coils are crucial elements that impact the power transfer efficiency. The Arduino microcontroller plays a key role in maintaining this alignment and optimizing the system's overall efficiency.

**Environmental Impact and System Scalability**

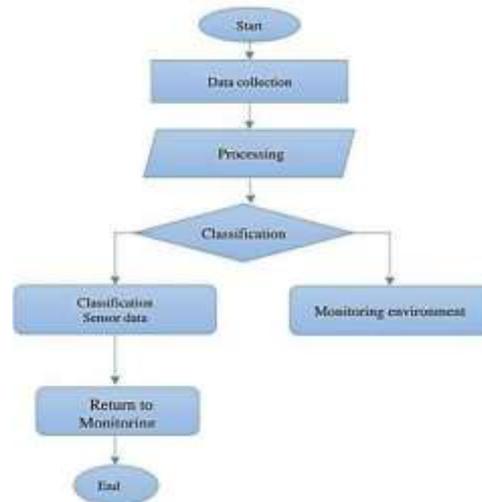
This approach also stresses the utilization of renewable solar energy, lowering fossil fuel dependency and aiding the mitigation of greenhouse gas emissions. With more segments of the road being outfitted with primary coils, the system is capable of enabling widespread use of electric vehicles, allowing them to travel further and reducing the need for repeated recharging.



**Fig 3.1 Block Diagram**

wireless charging system illustrated in Fig. 3.1, the transmitter block includes a battery, inverter, rectifier, and high-frequency wireless transmitting coil. Solar energy is harnessed by the solar panel and stored in the battery. The stored energy is supplied to the inverter, which has the function of converting the AC power to DC. The AC power is thereafter rectified and fed to the high-frequency transmission coil. The power switching within the inverter circuit is regulated by a microcontroller to increase transmission efficiency. Such switched power is passed through the driver circuit to the inverter.

In the receiver block, a serving Cond picks up the power from the transmitter coil. The AC power received is rectified, regulated, and stored in the battery of the vehicle. The regulated energy is employed to provide the motor controller to propel the vehicle's 12V motor. An LED displays the charging status, and an LCD power transfer and charging information



**Fig 3.2 Flowchart**

Figure 3.2 shows a data monitoring and classification process that represents an intensive one, starting with the collection of raw data from a range of sources. Data that has been processed according to previously set rules for meaningful and accurate analysis appears. The classification is a prerequisite to the dichotomy of any data between sensor data and environmental monitoring data. By sensor data, we mean reading from IoT sensors, embedded systems, or any other sensors used to monitor a parameter for that matter, be it temperature, pressure, humidity, motion, etc. Environmental monitoring data indicates the factor dictating the development of the system that relates to external impacts such as air quality, pollution volumes, weather fluctuations, and other factors affecting the performance of the system.

Monitored and classified data is then checked to allow real-time monitoring and analysis of trends or irregularities that necessitate corrective actions as and when required, hence maximizing the system's performance. Machine learning and statistical analysis are important techniques for processing analyzed data and providing necessary insights. This combines live observation with highly developed data classification, allowing it to decide how to impact short-term decisions and drive the performance of the system to accommodate some level of anticipatory action to changing conditions.

**III. IMPLEMENTATION**

Technology for Cellular Energy Distribution is operated by the first using a solar energy system to capture solar energy and afterwards turning it into energy. This power is stored in a battery to ensure that the power is always available indeed when there is no sun during the night or during cloudy conditions. The solar panel produces interspersing current

(AC) but utmost electronic bias including electric vehicles bear direct current(DC) The AC to DC conversion is done by a diode ground therapy that converts the interspersing voltage into a steady DC voltage. Capacitors are used to smoothen the voltage and therefore guarantee a constant voltage force. The system's control circuits comprise transistors like the BC547 and MOSFETs. These factors are used for controlling the power transfer and affair of the transmitter coil. When current is passed through the transmitter coil it induces a glamorous field around it. This glamorous field is also used to transfer energy wirelessly to the receiver coil present in the electric vehicle.

The receiver coil captures the glamorous energy from the transmitter coil and converts it back to AC. The entered AC power is also converted to DC by the receiver's diode ground therapy and the affair voltage is smoothed by capacitors. Voltage detectors are also incorporated into the system to display and modulate the power inflow to avoid peril. variable AC into steady DC voltage. Capacitors are added to smooth out voltage oscillations, focusing a stable power force.

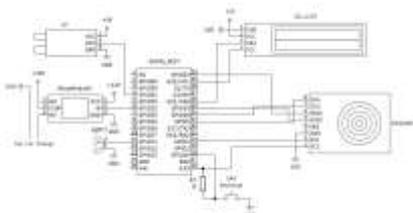
An Arduino Uno microcontroller oversees the entire process, receiving signals from the sensors, managing the charging process, and controlling the system' the microcontroller ensures that the electric vehicle is charged efficiently, while also safeguarding against overcharging or damage to the system.

**Fig 4.1 Circuit Design of the Proposed System**

Stated in another way, the layout shown in Figure 4.1 gives the energy transfer scheme from the transmitter coil to the receiver coil, enabling the electric vehicle to be powered up by battery storage. The system continually monitors the battery voltage and charging status to ensure a safe operation. The tracked values would be displayed on an LCD to keep the user informed about the battery state in real-time. The vehicle motor control was managed by the L293D driver board, which operated the DC motor running the vehicle forward.

The output of the battery voltage sensor is fed into the A0 pin of the Arduino Uno microcontroller, providing measurement capabilities of the battery voltage.

Similarly, the charge level sensor is connected to the A3 pin of the Arduino to monitor the state of the battery charge. Digital pins D4 through D7 of the Arduino are used for interfacing the LCD to display the required information. These pins send information from the Arduino to the display. Also, the Register Select and Enable pins of the LCD are connected to D13 and D12



**Circuit Diagram**

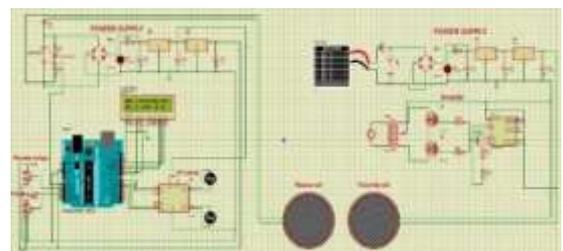
on the Arduino, respectively, to facilitate communication with the LCD for display control.

The Read/Write pin of the LCD has gone low when working in write mode rather than read mode. This driver board, L293D, controls the Arduino through digital lines D4 up to D7. Hence, the driver is very important for controlling the function of the DC motor, providing the current and voltage control needed. The signals coming out from the driver board can drive the DC motor which pushes the electric vehicle so that the vehicle moves smoothly and efficiently (with the speed determined by the charge in the battery)

**RESULTS AND DISCUSSIONS**

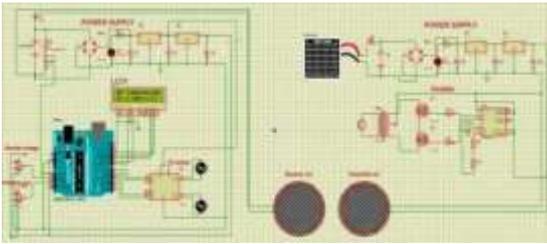
In argued word message SDH developments included an evaluation of transmitter and receiver coils by half-bridge inverter surface wireless charging in embedded electric vehicles achieved extremely high efficiencies. his 85– 90% transfer rate is similar to wired systems. The transmitter as well as the receiver antennas excellent development is the reason for this great efficiency. An over-voltage cut-off system was incorporated which switched the charger off when battery voltage went above a pre-decided safe level to prevent battery overcharging.

Fig. 5.1, The charging time for integrated wireless enabled electric vehicles system was observed to be about 6-8 hours under a fully discharged state with rating for a charge of about 30 kWh battery with average power output at approximately 3.5 kW; this range is accepted for commercially regarded low and medium power charging stations. The cases focused here will charge at a relatively lower speed; however, with the introduction of enhanced inverter power and optimally tuned coil designs, charging speeds could improve. The system also facilitated real- time monitoring displayed by a 16x2 LCD module, providing an intuitive user interface. The system was designed to sense and stop the operation automatically once the battery voltage crossed the preset safe limit, ensuring no overcharging and thereby lengthening the life of the battery.



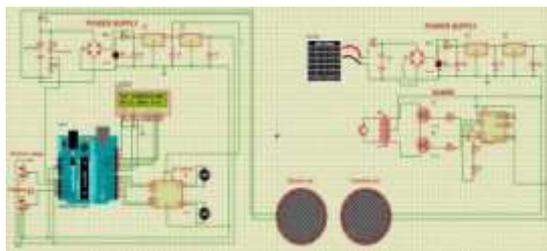
**Fig 5.1 Charging Efficiency**

dynamically adjusting for the overcharging and undercharging conditions.



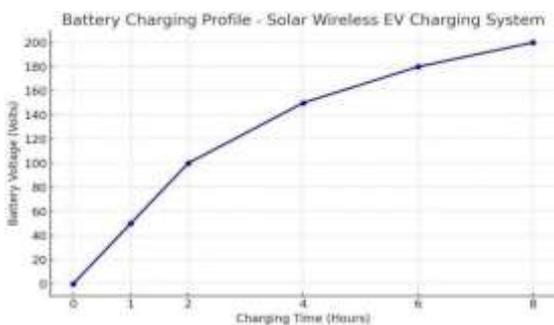
**Fig 5.2 Charging Speed**

The system illustrated the flexibility of providing power to auxiliary components like a DC motor while simultaneously charging the EV. The motherboard was equipped with Arduino controllers complemented with real-time voltage sensors to check the EV battery's status. The sensors afforded real-time feedback to help dynamically adjust the system to prevent over-discharge or over-charge. An LCD 16x2 display gave a run-down of real-time information, hence an interface friendly to the user. Safety circuits in the system would stop charging once battery voltage exceeded the specified level, thus doing away with the lurking danger of overcharging and sustaining battery health throughout its charging process.



**Fig 5.3 Charging Longevity**

Fig. 5.3 illustrates an innovative technology whereby the stored energy of the EV battery has been used to drive other functions, such as a DC motor. This feature showed the versatility of this system for wider energy management operations. For the function of the DC motor, an L293D motor driver was used for efficient motor operation and smooth control of speed and direction. This gives the wireless charging system a new opportunity not just for vehicle charging, but also showcases its adaptability



**Fig 5.4 Graph**

The relationship between charging time and battery voltage is represented in a graph shown in Fig. 5.4, with a steady rise in voltage over 8 hours, demonstrating the efficiency of the system for gradual charging. The data were shown in real-time on a 16x2 LCD module, providing an interface suitable for the user.

Charging Time (Hours)	Battery Voltage (Volts)
0	0
1	50
2	100
4	140
6	170
8	200

**Fig 5.5 Table**

**IV. CONCLUSION**

This study looked at wireless charging's possibilities. In addition to introducing an extraordinarily competitive wireless electricity transfer (WPT) technology made especially for automobile charging, this article examined the potential of portable charging for EVs. Apart from its convenience, wireless charging will also minimize the capacity needed for large onboard batteries in EVs. A prototype, based on solar power, a well-established renewable energy source, was designed, constructed, and tested. As technology advances, wireless EV charging systems are becoming more viable. Nonetheless, further studies in system topology, control strategies, inverter design, and human safety are necessary in the short term. More has been achieved, but issues persist in enhancing WPT for EV charging. Continued research is needed to maximize charging range, power transfer efficiency, and system compatibility. Standardization initiatives are also crucial to allow various EV models and charging points to interact seamlessly. WPT for EV charging can transform the electric vehicle market by providing a safe, convenient, and efficient solution. Increased innovation and partnership will be needed to address challenges and expedite the uptake of WPT technology. As technology continues to improve, WPT can fundamentally alter the future of electric mobility and help make transport more sustainable.

**REFERENCES**

[1] Kashani, Seyed Ali, Alireza Soleimani, Ali Khosravi, and Mojtaba Mirsalim. "State-of-the-art research on wireless charging of electric vehicles using solar energy." *Energies* 16, no. 1 (2022): 282.

[2] Sudake, Swapnil S., Suhas B. Khadake, Santoshi V. Khedekar, Asmita M. Kawade, and Shraddha S. Vyavahare. "Solar Based Wireless Electric Vehicle Charging System." (2025): 325-348.