



SUSTAINABLE WIRELESS CHARGING STATION FOR ELECTRIC VEHICLES USING SOLAR ENERGY

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Abstract : Using wireless power transfer (WPT) technology, this proposal suggests a solar-powered wireless charging station for electric cars (EVs). The EV's reception coil receives power from a transmitter coil and transforms it from AC to DC in order to charge the battery. The system's charging circuits guarantee unidirectional current flow through diodes, and it can be powered by solar panels or the grid. With the help of a 12V, 1A transformer and a 12V, 3W solar panel, the battery pack (12V, 1A) can be fully charged in 4–5 hours. The device eliminates the need for wires and connectors by converting 12V DC to AC for wireless transmission across a distance of 5–6 cm. Wireless charging combined with solar energy offers a practical and ecological alternative for EV infrastructure in the future.

IndexTerms – Solar charging, inductive power transfer, wireless energy transmission, electric vehicles, renewable energy, sustainable transportation.

I. INTRODUCTION

Electric vehicles (EVs) are becoming more and more popular around the world as environmentally friendly substitutes for cars with internal combustion engines because of their ability to lower greenhouse gas emissions, lessen air pollution, and increase overall energy efficiency [1]. Notwithstanding these benefits, there are a number of drawbacks to conventional plug-in charging techniques, such as the restricted availability of charging stations, connector deterioration, and susceptibility to environmental elements like dust, rain, or corrosion [5][9]. These issues can cause consumers to experience inconvenience and shorten the lifespan of charging equipment, underscoring the need for more reliable and approachable solutions [5].

Energy transfer without physical touch is made possible by wireless charging, which is based on the electromagnetic induction principle [1][2] and presents a promising substitute. Users will find this technology more convenient since it improves safety, lowers maintenance requirements, and streamlines the charging process [5]. Furthermore, wireless charging opens the door for intelligent and self-driving transportation infrastructure by enabling automatic and dynamic charging systems, such as charging while parking or even while moving on properly designed highways [2][6].

Sustainability is further enhanced when solar energy is incorporated into EV charging infrastructure [7][8]. Rechargeable batteries can store the electrical energy produced by solar photovoltaic (PV) panels, which capture the abundant renewable energy from sunshine [3]. The vehicle's receiver coil receives this stored energy once it has been transformed from DC to AC and wirelessly transferred [5]. Especially in places with restricted grid access, such integration not only lessens dependency on traditional grid power but also fosters resilience and energy self-sufficiency [8].

Through the integration of wireless charging and solar energy harvesting, the suggested system offers a user-centred, effective, and environmentally friendly solution for the changing transportation environment. Reducing carbon footprints and promoting sustainable mobility in both urban and rural areas are two ways that this strategy supports smart city projects, promotes the use of renewable energy, and supports the Sustainable Development Goals (SDGs) of the UN 8[9].

II. SURVEY OF LITERATURE

Wireless and renewable energy-based electric vehicle charging systems have been studied by a number of researchers. In order to improve power transfer efficiency and lower coil misalignment losses, examined resonant inductive coupling approaches [5]. Using segmented coils demonstrated a dynamic wireless charging solution for EVs in motion [6].

Hybrid charging stations that are powered by solar PV modules with grid backup to guarantee continuous operation were investigated. In their discussion of solar-integrated EV charging in rural India emphasized the sustainability of this technology [8]. According to these studies, combining solar energy systems with wireless power transmission can successfully get over the drawbacks of traditional wired charging while encouraging environmentally friendly mobility.

III. EXISTING SYSTEM

Plug-in connectors power the traditional EV charging method, which necessitates manual operation and ongoing grid dependence [5]. There are various issues with this system:

1. In moist conditions, physical connectors are vulnerable to corrosion, wear and tear, and safety risks [9].
2. Indirect carbon emissions are caused by grid-based power unless it comes from renewable sources [10].
3. The infrastructure and maintenance costs of charging stations are high [7].
4. Inconvenient and limited portability for short-range or emergency use [5].
5. Therefore, a contactless, self-sufficient charging system that makes use of renewable energy is obviously needed [7][8].

IV. PROPOSED SYSTEM

Photovoltaic power generation, energy storage, and wireless transmission are all combined into one small device in the proposed Solar-Powered Wireless Charging Station [7]. PV panels transform solar radiation into electrical energy. kept in a battery and controlled by a charge controller [3]. An alternating magnetic field is created by feeding the stored DC to a transmitter coil after it has been converted to high-frequency AC [1][5].

This magnetic field is captured by a receiver coil installed on the EV, which then generates current that is rectified and controlled to wirelessly charge the battery. The entire procedure uses clean, renewable energy and does away with physical cords.

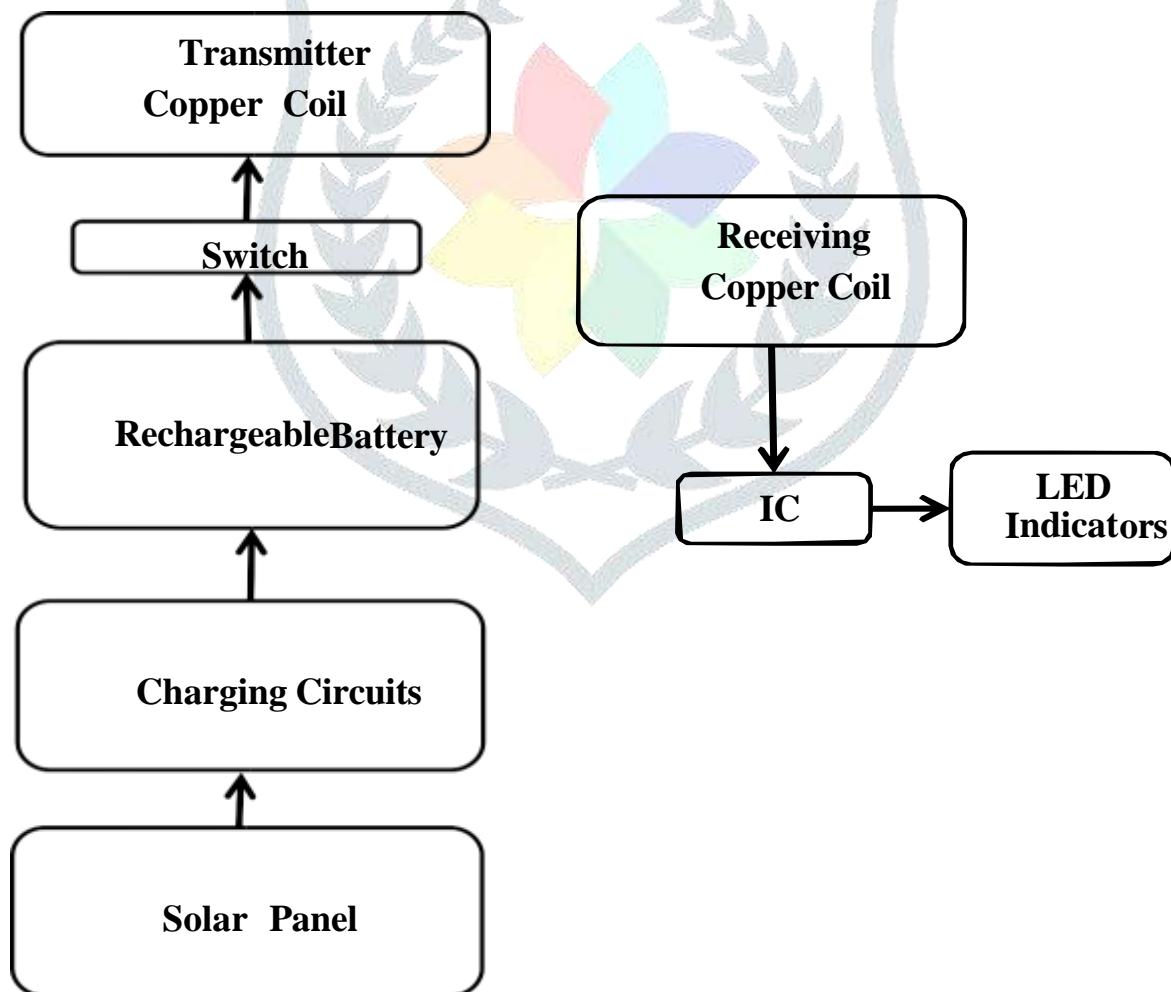


Fig. 1 : Block Diagram of Sustainable Wireless

There are two main parts to the system.

1. Section for Transmitting (Charging Station):

- solar panels capture's the Sunlight and transforms into electrical energy.
- This power is conditioned by the charging circuit before being stored in a rechargeable battery.
- Through a control switch, the transmitter coil receives the stored DC power, creating an alternating magnetic field.

2. Vehicle Side Receiving Section:

- This magnetic field is captured by the EV's receiver coil using electromagnetic induction.
- The vehicle's battery is charged by rectifying and regulating the induced AC voltage.
- Power availability and charging status are shown by LED indicators.

Contactless energy transfer is made possible by this architecture, guaranteeing safe and effective charging even in the event that the grid supply is not available.

V. COMPONENTS

5.1 Regulated Power Supply

For delicate parts like ICS and LEDs, the regulated power supply (RPS) supplies a steady DC voltage [9]. The circuit is shielded from voltage swings by a transformer, bridge rectifier, filter capacitor, and voltage-regulator integrated circuit (LM7805), which maintain a steady 5 V output.

5.2 Solar Panel

A solar panel uses the photovoltaic effect to transform sunlight into electrical energy [3][7]. The necessary voltage and current are obtained by connecting several cells in parallel and series. The panel saves extra energy in a battery for later use in addition to powering the charging circuit [7][8].

5.3 Charging Circuit

To provide a steady DC voltage for battery charging, the charging circuit filters and rectifies the solar output. Capacitors eliminate voltage ripples, and a bridge rectifier transforms AC-like pulsations into DC [9]. LEDs show system health and charging activity.

5.4 Rechargeable Battery

The transmitter coil is powered by a 12 V rechargeable battery that reserves solar energy for use at night or in overcast weather. Because of their high energy density and quick charge time, lithium-ion batteries are recommended [5].

5.5 Copper Coils

One copper coil is used for transmission, and the other is utilized for reception [1][2]. The transmitter coil creates a magnetic field when alternating current passes through it. By using inductive coupling, the receiver coil, which is positioned close by, absorbs this energy. The excellent conductivity of copper guarantees less energy loss [5].

5.6 LED Indicators

LEDs give visual data on the state of the system, including failure indication, power availability, and charging activities.

VI. PROJECT DESCRIPTION

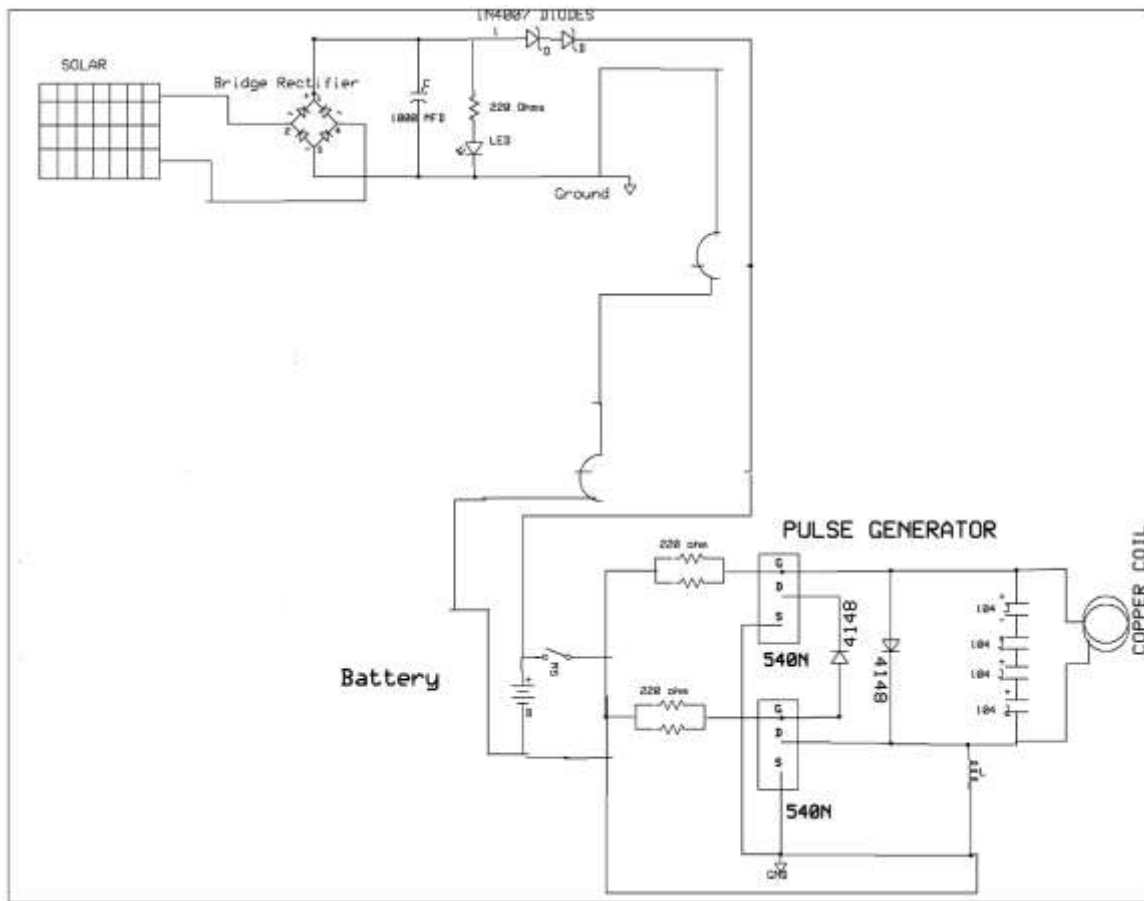


Fig. 2 : Schematic Diagram of Solar Wireless EV Charging System

The experimental configuration of the system consists of a load, rectifier, regulator, sending and receiving coils, and a pulse generator. The two coils are made to resonate at the same frequency in order to maximize functionality [2]. The inverter and solar-charged batteries power the transmitter coil, which produces an electromagnetic field [1].

A frequency generator, adjusted to the coils' resonance frequency, generates the required excitation frequency (100 kHz). This energy is captured by the receiver coil and sent to a rectifier-regulator circuit to charge an EV battery or load. Stable operation is possible up to 10cm, however power transfer efficiency drops with increasing coil distance.

The complete system provides a viable and sustainable alternative for contemporary transportation systems by showcasing the efficient use of renewable solar energy for wireless EV charging,

VII. RESULTS AND DISCUSSION

The transmitting coil in the transmission section is powered by solar energy that is captured and stored in the battery. This energy is captured by the receiving part using an inductive connection, which then charges the vehicle's battery.

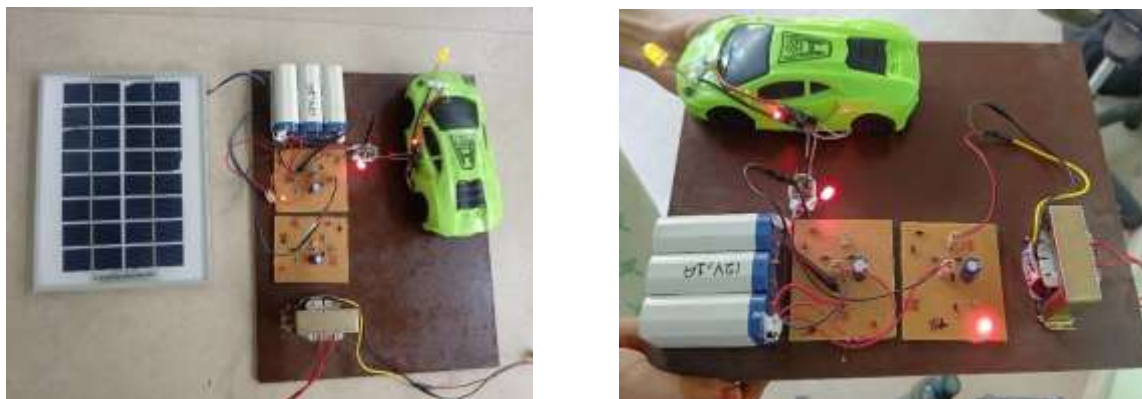


Fig. 3 : Solar Wireless Charging Station Prototype Configuration for EVs

Based on experimental results, the device is able to wirelessly transfer power over a distance of 5-10 cm using a signal frequency of 100 kHz [2]. The output is sufficiently high to charge small EV batteries and light up indicator LEDs after the transmitted AC voltage is rectified to DC.

This prototype highlights the potential scalability of solar-based wireless power transfer for actual EVs and shows that it is feasible [5][7].

VIII. CONCLUSION

The project "Sustainable Wireless Charging Station for Electric Vehicles using Solar Energy" offers a creative method of charging cars in an environmentally friendly and effective manner. Through the integration of wireless power transfer and sustainable solar energy, the system does away with physical connectors, lowers maintenance costs, and guarantees user safety in all weather.

The created prototype offers a more affordable and environmentally responsible option to plug-in charging systems while achieving wireless energy transmission of up to 10 cm. Future enhancements could involve incorporating smart-charging control, improving coil alignment, and scaling the concept for EV batteries with larger capacities.

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