



International Journal of Research Publication and Reviews

Journal Homepage: www.ijrpr.com ISSN 2582-7421

Smart Solar and Grid Assisted Dynamic Wireless Power Transfer System for Electric Vehicles with Automatic Billing and Power Monitoring

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DOI : <https://doi.org/10.55248/gengpi.07.1026.3230>

ABSTRACT -

The increasing adoption of Electric Vehicles (EVs) has created a need for efficient, convenient, and intelligent charging infrastructure. Conventional plug-in charging requires the vehicle to remain stationary and physically connected to a charging point. This project proposes a Smart Solar and Grid Assisted Dynamic Wireless Power Transfer System for Electric Vehicles with Automatic Billing and Power Monitoring to overcome these limitations. The proposed system uses wireless power transfer (WPT) technology to transfer electrical energy from a transmitter coil installed below or along the roadway to a receiver coil installed underneath the electric vehicle. The system can receive energy from both solar photovoltaic (PV) panels and the electrical grid. Solar energy is given priority when sufficient power is available, while grid power is used as a backup or supplementary source. During vehicle movement over the charging section, wireless charging can be activated automatically using vehicle detection and control circuitry. Sensors measure parameters such as voltage, current, power, energy consumption, and charging duration. A microcontroller or IoT controller sends the measured data to a monitoring platform. An automatic billing module calculates the charging cost based on the amount of electrical energy transferred to the vehicle. The system can therefore provide contactless charging, renewable-energy utilization, real-time power monitoring, energy measurement, and automatic billing in a single platform. The proposed system can be useful for smart highways, EV charging lanes, parking areas, bus stops, commercial charging stations, and future intelligent transportation infrastructure.

INTRODUCTION

Electric vehicles are becoming an important part of modern transportation because they can reduce dependence on conventional fossil fuels and can be powered using renewable energy sources. However, EV charging infrastructure remains one of the important challenges in large-scale EV adoption. Traditional EV charging systems generally require a physical cable between the charging station and vehicle. The user must park the vehicle at a suitable location and connect the charging cable manually. Cable-based charging can also create problems related to connector wear, weather exposure, user convenience, and charging accessibility. Wireless Power Transfer (WPT) provides an alternative method in which electrical energy is transferred without a physical electrical connection. In an inductive WPT system, a transmitter coil generates an alternating magnetic field and a receiver coil captures the magnetic field and converts it back into electrical energy for charging the vehicle battery. The concept can be extended to Dynamic Wireless Power Transfer (DWPT), where c

OBJECTIVE

1. To develop a hybrid wireless EV charging system using solar energy and grid power for reliable and continuous charging.
2. To implement automatic EV detection using an IR sensor and enable contactless charging through transmitter and receiver coils.
3. To monitor and display important charging parameters such as voltage, current, power, battery status, charging time, and energy consumption.
4. To develop an automatic billing system that calculates the charging cost based on energy consumed and charging duration

LITERATURE REVIEW

1 Wireless Power Transfer for EV

: -Transfer of electrical power from a transmitter coil to a receiver coil without physical connectors.

- Efficiency decreases with coil misalignment and distance.

2 Dynamic Wireless Charging

: - EV is charged while moving over charging coils installed in the road.

- Requires proper coil placement and higher infrastructure cost.

3 Solar-Assisted EV Charging

: - Solar PV is used as a renewable energy source for EV charging.

- Solar power is intermittent and depends on weather conditions.

4 Grid-Assisted EV Charging

: - Grid supplies power when solar generation is insufficient.

- Increased grid dependency and electricity cost during some periods.

5 Hybrid Solar-Grid Charging

: - Solar and grid sources are combined to provide continuous charging.

- Requires proper energy-management and source-selection control

6 Automatic Billing System

: - Voltage, current and charging time/energy are measured to calculate charging cost automatically.

- Billing accuracy depends on reliable energy measurement and communication

7 EV Power Monitoring

: - Sensors measure voltage, current, power and energy consumed during charging.

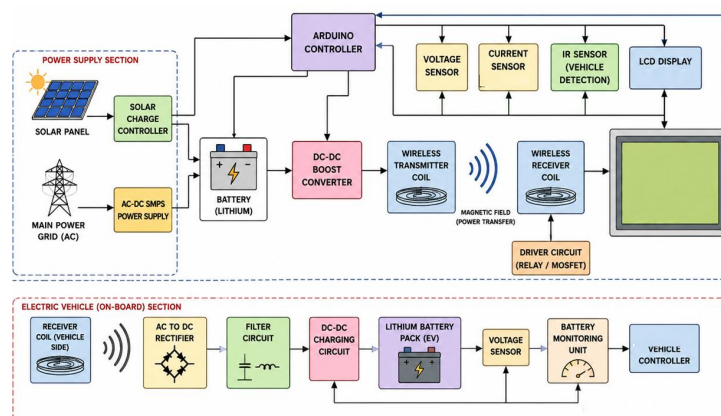
- Requires suitable sensors and a reliable monitoring system.

8 Smart Wireless EV Charging

: - Combines wireless charging, sensors and automatic control for intelligent EV charging.

- Many system focus on charging only and do not integrate renewable energy ,billing and monitoring together.

METHODOLOGY



- The solar panel converts sunlight into electrical energy, which is stored in a lithium battery through a solar charge controller. When solar power is insufficient, the main power grid supplies energy to maintain continuous system operation.
- The Arduino controller continuously monitors the power sources and controls the complete wireless charging process.
- An IR sensor detects the presence of an electric vehicle over the wireless charging pad and activates the charging system automatically.
- A DC boost converter regulates and increases the DC voltage supplied to the wireless transmitter coil for efficient power transfer.

- The energized transmitter coil creates a high-frequency magnetic field that transfers energy wirelessly to the receiver coil installed beneath the vehicle.
- The received power is rectified into DC and used to charge the vehicle's lithium battery, while voltage and current sensors monitor charging parameters continuously.
- The Arduino calculates charging time, energy consumed, and charging cost, displaying voltage, current, power, battery status, and total cost on the LCD. Charging automatically stops when the vehicle leaves the charging zone.

EQUIPMENT DETAILS

Components	Quantity	Ratings
Solar Panel	2	6V, 3mh
Ardiuno Controller	1	Model No: UNO
Voltage Sensor	1	3.3V
Battery	1	12V, 1200mh
Lithium Ion Cell	2	6V, 1200mh
LED Display	1	16*2
Transmitter Coil	3	3.3V, 3mh
Receiver Coil	2	3.3V, 3mh
Battery Indicator	2	12V, 4-level

RESULT

The proposed system was successfully designed to demonstrate wireless charging of an electric vehicle using solar energy with grid assistance. The system detects the presence of the EV on the charging pad and automatically starts wireless power transfer. When solar power is insufficient, the grid supply can assist the charging system.

The transmitter coil produces a high-frequency magnetic field, which transfers power to the receiver coil installed on the EV. The received AC power is rectified and converted into suitable DC power for charging the battery. Voltage and current sensors continuously monitor the charging parameters.

The monitoring system displays important parameters such as voltage, current, power, energy consumed, charging time and estimated charging cost. The automatic billing section calculates the charging cost based on the energy consumed. When the EV moves away from the charging zone, the system detects its absence and stops the charging process.

CONCLUSION

The proposed Smart Solar and Grid Assisted Dynamic Wireless Power Transfer System for Electric Vehicles with Automatic Billing and Power Monitoring combines renewable energy, wireless charging, IoT, energy measurement, and automated billing into a single smart EV charging concept. The system uses solar power as a renewable energy source while retaining grid power as a backup or supplementary source. Wireless power transfer eliminates the need for direct physical charging connections, while multiple transmitter sections can be used to demonstrate dynamic charging as a vehicle moves through the charging lane. The monitoring subsystem measures voltage, current, power, and energy consumption. This information can be transmitted to an IoT dashboard for real-time monitoring. Based on the measured energy, an automatic billing module can calculate the charging cost. The proposed system demonstrates how EV charging infrastructure can evolve from conventional plug-in charging toward automated, renewable-assisted, connected, and intelligent charging systems. For a student prototype, the project can be implemented at low power using an ESP32/microcontroller, solar panel, wireless power-transfer module, sensors, vehicle-detection system, display/dashboard, and simulated EV battery load. A higher-power implementation would require specialized EV wireless charging power electronics, certified metering, protection systems, and compliance with relevant standards..

FUTURE SCOPE

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