EV CHARGING STATION WITH ON GRID GREEN POWER AND WIRELESS CHARGING

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Abstract

Researchers have long been intrigued by the quest to conserve energy, especially with the rise of electric vehicles (EVs) in the 19th century. With many countries still reliant on traditional energy sources, connecting EVs to renewable energy offers a promising solution. This involves using parking spaces as charging points powered by clean energy sources like solar, wind, and hydroelectric power. To make charging easier, wireless technology has been introduced, along with vehicle-to-grid (V2G) integration, allowing power to flow between the vehicle and the grid. This report explores the benefits of combining renewable energy with wireless charging for EVs, detailing different charging methods and their environmental and economic impacts. It also discusses real-world examples and future trends in this growing field.

Introduction

The idea of wirelessly charging devices dates back to Tesla's time, but lacked technical support. In 2007, researchers made progress by controlling light from a wireless source two meters away. Since then, wireless power transmission (WPT) has advanced, with electric vehicle (EV) charging being one application under study.

Traditional wired charging systems, also called conductive charging systems, have drawbacks like thick cables, manual connections, and environmental unfriendliness. They may also pose risks like short circuits or electric shock.

To address these issues, researchers are exploring wireless charging systems (WCS), which can charge multiple batteries simultaneously or even swap out batteries for faster charging. However, batteries also have their own challenges.

<u>This study covers the following key points:</u>

- Providing results and insights on relevant questions.
- Offering an introduction to WPT before diving into EV wireless charging systems and methods.
- Reviewing both single- and double-wireless charging system designs.
- Examining an inductive power transfer (IPT)-based double-wireless charging system prototype and its design.
- Discussing communication, power management, and system compatibility in wireless charging systems.

Methodology

A new type of charging station for electric vehicles (EVs) is emerging, powered entirely by solar energy. When designing these solar stations, several factors are considered, like location, annual sunlight exposure, tilt angle of solar panels, number of panels, temperature, shading, and cooling systems.

These solar stations use Direct Current (DC) power, which avoids harmonic issues and makes them more efficient than traditional AC power grids. In fact, DC micro-grids can generate more energy and improve transmission efficiency while reducing costs. They can even operate independently if needed, providing backup power during outages.

In addition to powering EVs, these stations can also feed excess energy back into the grid, potentially earning money. They're designed to be fault-tolerant, meaning they can still function even if parts fail. Some solar stations incorporate diesel technology to provide additional power without needing extra equipment.

Solar panels capture sunlight and convert it into electricity through a process called photovoltaic conversion, which is efficient and environmentally friendly. These stations are designed to be versatile, capable of operating even in areas with limited sunlight. However, to meet high demand, hybrid charging stations combining solar and other power sources are being considered.

The key features of these solar charging stations include their ability to operate independently, even without AC power, and their integration of renewable energy, storage, backup, and AC power modules. This integrated approach optimizes energy distribution and ensures reliable charging for EVs.

- **Working Principal**

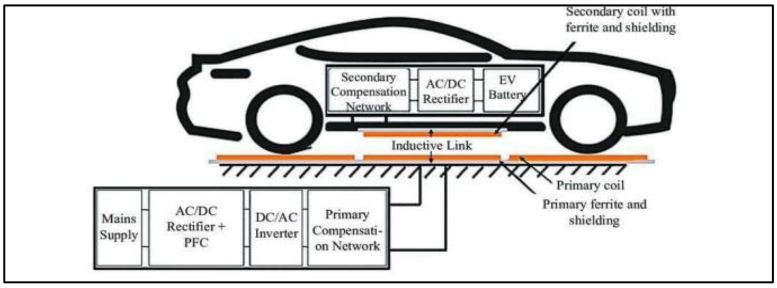
Tesla coils serve as high-voltage transformers used for transmitting electricity without wires. They operate uniquely compared to regular transformers, providing more power and generating a higher frequency output, which significantly impacts the load.

Here's a simplified breakdown of how they function: A high-voltage generator charges a capacitor, which temporarily stores electricity. Once the capacitor reaches full charge, it's linked to a specialized switch known as a gap. This connection ionizes the air between the switch's electrodes, resulting in the production of electricity.

Primary capacitors within Tesla coils can be configured in series or parallel. One end connects to the primary coil, and the other attaches to the high-voltage generator. Meanwhile, the RF ground is connected to the first coil.

Overall, Tesla coils stand out for their ability to transmit electricity wirelessly, leveraging their unique design and operation to deliver significant power and frequency output to the intended load.

- **Block Diagram**



- **Objective of Project**

The objective of the project "EV Charging Station with On-Grid Green Power and Wireless Charging" is to develop an environmentally sustainable and technologically advanced electric vehicle (EV) charging infrastructure. This project aims to achieve the following objectives:

1. Provide Convenient and Eco-Friendly Charging: Create a network of EV charging stations powered by on-grid green power sources such as solar or wind energy. This will reduce carbon emissions associated with transportation and promote sustainable energy usage.
2. Enhance User Experience: Implement wireless charging technology to simplify the charging process for EV users. By eliminating the need for physical cables, this technology will improve convenience and accessibility, potentially increasing EV adoption rates.
3. Reduce Dependence on Fossil Fuels: By utilizing renewable energy sources for charging, the project aims to reduce reliance on fossil fuels for electricity generation, contributing to efforts to combat climate change and air pollution.
4. Foster Technological Innovation: Demonstrate the feasibility and effectiveness of integrating wireless charging technology with green power sources in EV charging infrastructure. This will encourage further innovation in the field of sustainable transportation and energy.
5. Promote Economic Viability: Analyse the cost-effectiveness and return on investment of EV charging stations powered by on-grid green power. By showcasing the economic benefits of this approach, the project aims to attract investment and support for similar initiatives.
6. Align with Government Objectives: Support government policies and initiatives aimed at promoting clean energy, reducing greenhouse gas emissions, and accelerating the adoption of EVs. By aligning with these objectives, the project will contribute to broader sustainability goals at the local, regional, and national levels.

Advantages

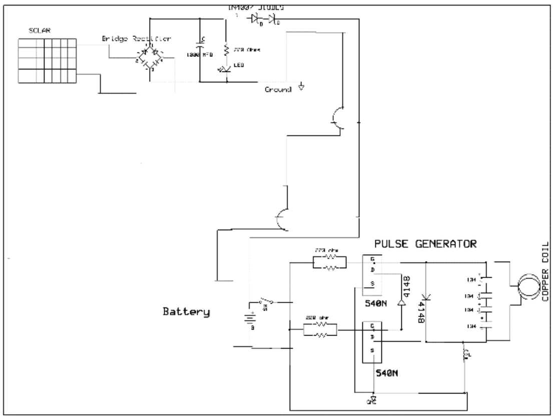
- Renewable energy source.
- One of the most significant advantages of solar-powered charging stations is that they use renewable energy from the sun to recharge EVs.
- Reduced carbon footprint.
- Reduce dependence on non-renewable energy sources.
- Low-cost energy source.

Disadvantages

- Charging stations vary in power outputs, with DC fast chargers capable of delivering significantly higher power compared to regular AC stations. While this facilitates rapid EV charging, it can also lead to increased heat generation and battery stress.
- Wireless charging for electric vehicles presents numerous benefits such as convenience, safety improvements, and environmental friendliness. However, it also poses challenges including lower efficiency, higher implementation costs, and issues with standardization.
- Once again, charging station power outputs vary, with DC fast chargers offering substantial power

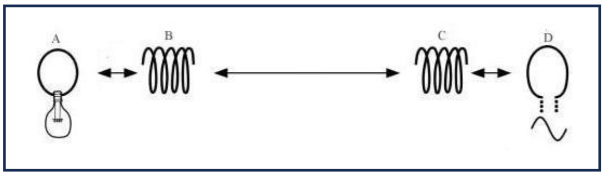
advantages over AC stations. While this enables swift EV recharging, it also raises concerns regarding heat production and battery strain.

Project Description



The above schematic diagram of **Solar Wireless Electric Vehicle Charging System** explains the interfacing section of each component.

Our experimental setup comprised six main components: the pulse generator, sending coil, receiving coil, rectifier, regulator, and load. Object A, representing the copper coil, consisted of a single loop of insulated copper wire. Objects B and C, denoting the sending and receiving coils respectively, were constructed from copper tubing and designed to resonate at identical frequencies. Object D, serving as the pick-up, was connected in series with a load for testing purposes.



The resonant frequency of our coils, which yields the highest power output, is influenced by the distance between them. To address this variability, we opted for a frequency generator to allow for frequency adjustment as necessary. While several oscillators were considered for generating specific frequencies, the frequency generator, akin to a pulse generator, was chosen due to the fluctuating nature of our resonant frequency. By outputting a signal matching the resonant frequency of our copper coils, the frequency generator enables maximum power delivery.

The generated signal is fed into our driving loop, constructed from 10-gauge wire. This loop, slightly smaller than our primary coil (approximately 55.5 cm in diameter), behaves as a dipole when subjected to AC current. Positioned parallel to the primary coil as closely as possible, the driving loop induces flux through the primary coil, initiating resonance. It's essential to note that the driving loop doesn't directly induce resonance in the secondary loop. Instead, evanescent waves emitted by the primary coil induce resonance in the secondary coil, given their identical shape, size, and mass. Both the primary and secondary coils consist of copper tubing with a 1/4 inch inner diameter and 3/8 inch outer diameter, each utilizing 60 feet of tubing and approximately 10 turns (57.5 cm in diameter).

At this stage, both coils resonate in parallel, consuming only enough power to drive the first coil. The distance between the primary and secondary coils determines the transmitted power magnitude, with power exponentially decreasing as the distance between them increases. When the secondary coil vibrates at its resonant frequency, it generates a stronger magnetic field. Positioned parallel to the secondary coil as closely as possible, the receiving loop, also constructed from 10-gauge wire, experiences induced current from the secondary coil's magnetic flux. This induced current drives a resistive load.

Result

- In transmission section we are using solar energy to charge the battery which is used to provide the power supply of the transmitting coil.
- In receiver section consist of copper coil which is connected to the vehicle battery. This coil receives the power from transmitting coil.
- This project results in a device where the electricity is transmitted wirelessly through copper coils for a distance range of about 10 cm. The system uses solar and pulse generator of 100 KHZ at the transmitter circuit. Therefore, the current flows from the coil on the transmitter side to the receiver side coil wirelessly connected with rectifier which converts AC voltage to DC voltage and this DC voltage is given to the battery for charging to drive the vehicle.

Conclusion

The transition from traditional fossil fuel-powered vehicles to electric vehicles (EVs) has seen a significant surge in recent times. There's now a pressing need for more EV charging stations along highways, akin to the ubiquitous presence of petrol pumps. However, this increased reliance on electric charging also translates to a higher demand for electricity.

To address this demand, authorities must consider expanding electricity generation capacity through various means such as hydro-power plants, thermal plants, etc. Yet, the continued use of fossil fuels exacerbates environmental pollution concerns. Consequently, there's a growing interest in grid-connected solar-powered EV charging stations as a sustainable alternative.

By harnessing solar energy, these charging stations can operate without adding to the burden on conventional power grids. Moreover, they can reduce the need for expensive battery storage systems by utilizing direct solar power during the day and providing stored energy for nighttime charging. Eliminating batteries also improves overall efficiency.

Through meticulous analysis using tools like PvSyst software, it's been determined that a 6 KW solar panel system is optimal for powering the charging unit. These findings were presented in a paper at the International Conference on Automation, Signal Processing, Instrumentation, and Control (iCASIC 2020), slated for publication in Springer proceedings under the "Advance in Automation, Signal Processing, Instrumentation, and Control" edition.

In terms of implementation, the solar panels have been installed on a building owned by the Kollam Municipal Corporation in Chinnakada, Kollam. Meanwhile, the charging unit has been erected on the ground adjacent to the building, strategically positioned near the roadside for convenient access. This initiative represents a step towards sustainable transportation infrastructure, promoting both environmental conservation and technological innovation.

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