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Solar Based Electric Vehicle Charging System-Review

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Abstract: *In today's world there are more outcomes in environmental change due to the overutilization of petroleum products in this manner prompting a genuine effect on the climate. So there is a need for a substitute answer for lessen the consumption of such non – sustainable assets. One such exertion made in the field of Freeways is the advancement of "Solar Freeways" which can be an elective arrangement.*
Sun oriented streets consolidate various arrangements in one – it can assist us with improving the creation of power utilizing sun based boards, to give a computerized stage to our future country's ventures like Smart Cities, and to work with the arising electric vehicles that supplant the petroleum driven vehicles and substantially more.
Motivated by the fact that there are numerous amount of clean and sustainable energy we receive from roadways, the following study puts forward some of the event and application of an innovative charging method for the renewable energy driven electric cars, buses by using the roadway and also implementation of revolutionary nanotechnology along with the latest best in the house power electronics and power system analysis tools.

Keywords: EVT, Power Electronics, Solar Based Electric vehicle charging System

I. INTRODUCTION

The rise of electric vehicles (EVs) signals a promising shift towards sustainable transportation, offering a solution to combat climate change and reduce reliance on fossil fuels. However, challenges persist in the charging infrastructure, with conventional stationary charging stations causing significant waiting times for vehicle owners [1-15]. This hinders the seamless integration of EVs into mainstream transportation systems.

To address this issue, our project aims to develop an innovative solution the Solar Wireless Charging System in Electric Vehicles [16-60]. By harnessing solar energy and wireless transmission technology, this system revolutionizes the EV charging landscape, enabling on-the-go charging to minimize downtime and enhance overall efficiency.Electric Vehicles represents a new concept in the transport sector around the world. It is expected that the market share of EVs will exponentially grow, comprising 24% of the U.S. light vehicle fleet in 2030, representing 64% light vehicle sales in this year. In this context, the EVs battery charging process must be regulated to preserve the power quality in the power grids. Nevertheless, with the proliferation of Ev's a considerable amount of energy will be stored in the batteries, raising the opportunity of the energy flow in the opposite sense[61-140].

In the future smart grids, the interactivity with the EVs will be one of the key technologies, contributing to the power grid autonomous operation. The concept of the on-board bidirectional charger with V2G and V2H technologies is introduced.The electric vehicle has become more competitive when compared to the conventional internal combustion engine vehicle due to lower carbon dioxide emission and raising fossil fuels. However, the EV was not widely adopted into the market due to some limitations such as high vehicle cost. limited charging infrastructure and limited all electric drive [141-174].

EVs are vehicles that are either partially or fully powered on electric power. Electric vehicles have low running costs as they have fewer moving parts for maintenance and are also very environmentally friendly as they use little or no fossil.

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II. PROBLEM STATEMENT

The power is converted to AC using a transformer and regulated using regulator circuitry. This power is now used to power the copper coils that are used for wireless energy transmission. A copper coil is also mounted underneath the electric vehicle. When the vehicle is driven over the coils energy is transmitted from the transmitter coil to the EV coil. note the energy is still DC current that is induced into this coil. Now we convert this to DC again so that it can be used t charge the EV battery. We use AC to DC conversion circuitry to convert it back to DC current. Now we also measure the input voltage using an A mega microcontroller and display this on an LCD display.Thus the system demonstrates a solar-powered wireless charging system for an electric vehicle that can be integrated into the road.

III. LITERATURE REVIEW

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IV. EXISTING SYSTEM AND THEIR GAP

Grid-Powered EV Charging Systems:

- **Description:** These systems rely on electricity from the grid to charge EVs, offering AC (Level 1&2**)** and DC fast charging options.
- **Challenges:** Dependence on non-renewable energy, grid strain, and environmental impact.
- **Gap Addressed:** Your project reduces grid reliance by using solar energy for EV charging, promoting sustainability.

Standalone Solar-Powered EV Charging Systems:

- **Description**: Use solar panels to generate electricity and charge EVs, often with battery storage for off-sunlight hours.
- **Challenges:** High setup costs, intermittent energy generation, and limited availability.
- **Gap Addressed:** Your system overcomes solar intermittency by using battery storage and optimizing wireless charging for convenience.

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Hybrid Solar + Grid-Powered Charging Systems:

- **Description:** Combines solar energy and grid power, switching between them to ensure consistent EV charging.
- **Challenges**: High installation costs and system complexity.
- **Gap Addressed:** Your system focuses purely on solar energy, reducing costs by eliminating the need for grid power.

Wireless EV Charging Systems:

- **Description:** Utilizes inductive coupling for contactless charging, available in static (stationary) and dynamic (in-motion) forms.
- **Challenges:** Lower efficiency and higher costs compared to wired systems.
- **Gap Addressed:** Your project integrates wireless charging with solar power, aiming to develop a dynamic charging system that works on-the-go.

Solar-Based Wireless EV Charging Systems:

- **Description**: Combines solar energy and wireless power transfer, still in experimental stages with limited applications.
- **Challenges:** High energy losses and infrastructure costs.
- **Gap Addressed:** Your project enhances efficiency and scalability of solar wireless charging, making it more practical and adaptable for widespread use.

V. PROPOSED MODEL DESCRIPTION

Proposed Model Description

The proposed model for your Solar-Based EV Charging System introduces a novel solution that combines solar power generation with wireless charging technology. This model aims to provide a sustainable, efficient, and convenient way to charge electric vehicles (EVs) using renewable energy. Below is a detailed description of the model:

Solar Power Generation

- **Solar Panels:-** The model incorporates solar panels as the primary source of energy. These panels convert sunlight into electrical energy, ensuring that the system operates on renewable power, reducing reliance on the conventional electricity grid.
- **Energy Storage:-** To overcome the intermittency of solar power (e.g., during cloudy days or nighttime), the system includes battery storage. Energy produced during peak sunlight hours is stored and used to charge vehicles when sunlight is insufficient.

Wireless Charging System

- **Inductive Coupling Technology:-** The core of the model is based on wireless power transfer (WPT) through inductive coupling. A transmitter coil is placed in the charging station or embedded in roads, and a receiver coil is installed in the EV. When the vehicle aligns with the transmitter, power is wirelessly transferred to the EV's battery.
- **Dynamic Charging: -** The model also supports on-the-go charging. This dynamic system enables vehicles to charge while moving over embedded charging pads on roads, reducing downtime and eliminating the need for vehicles to stop and plug into a charger.

Power Conversion and Management

- **DC-DC Converter:-** The solar panels generate DC power, which is converted into the required voltage levels using a DC-DC converter to optimize power transmission to the battery and charging system
- **AC-DC Conversion:-** If the vehicle requires AC power, the system includes an AC-DC converter to convert the wireless-transmitted AC back into DC for the vehicle's battery.

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- **Charge Controller:-** A charge controller regulates the flow of energy from the solar panels to the storage system and the EV, preventing overcharging and ensuring efficient energy use.

Monitoring and Control System

- **Microcontroller (Arduino):-** The system is controlled by an Arduino Uno microcontroller, which manages the power transfer, monitors the system's performance, and displays real-time data (such as charging status, power levels, etc.) on an LCD screen. This provides transparency and enhances the user experience.
- **User Interface:-** The LCD display informs the user of key metrics like charging status, battery levels, and solar power availability.

Sustainability and Scalability

- **Environmental Impact:-** The system operates solely on solar energy, making it an environmentally friendly option that helps reduce carbon emissions and reliance on fossil fuels.
- **Scalable Design:-** The model is scalable, meaning it can be deployed in various settings— residential homes, commercial parking lots, or large-scale public roads. This flexibility allows for easy integration into existing infrastructures.

Future Potential and Scope

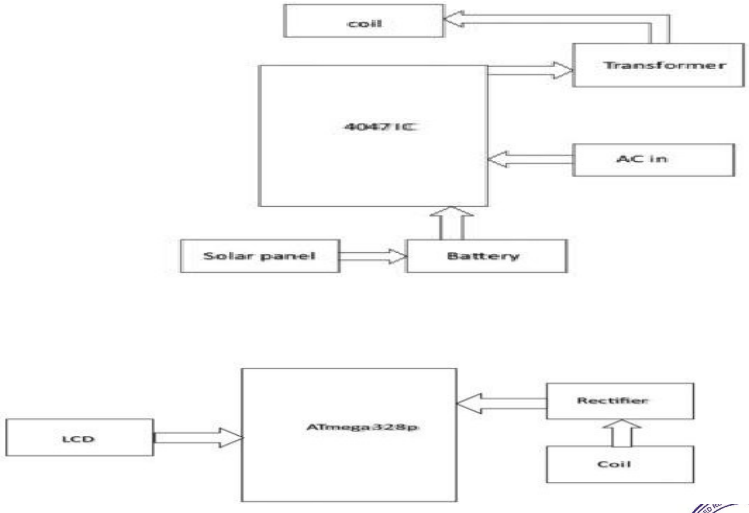
- **Smart City Integration:-** The proposed model has the potential to be integrated into smart city infrastructure, where roads are embedded with charging pads powered by solar energy. This could facilitate seamless EV charging across entire urban areas.
- **AI Integration:-** In the future, the system could incorporate AI algorithms to optimize charging efficiency, predict energy needs, and improve battery longevity.

VI. BLOCK DIAGRAM & EXPLAINATION

Description of Each Block:

Solar Panels:

Solar panels are devices that convert sunlight into electricity using photovoltaic (PV) cells. These cells capture sunlight and generate direct current (DC) electricity, which can be used to power electrical devices or stored in batteries for later use. Solar panels come in various sizes and efficiencies, with newer models being more effective at capturing energy. They are an essential component of any solar power system, providing the renewable energy needed to reduce reliance on fossil fuels. Solar panels typically have a long lifespan, usually



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6.1 Block Diagram

around 25 years, and require minimal maintenance after installation. Their effectiveness can vary based on factors such as geographical location, sunlight exposure, and installation angle.

Function: Captures sunlight and converts it into DC electrical energy, serving as the primary energy source for the system.

Charge Controller:

A charge controller is a vital component in a solar power system that regulates the voltage and current flowing from the solar panels to the battery storage. Its primary function is to prevent overcharging, which could damage the battery, and to ensure that the battery is charged at the correct voltage. There are two main types of charge controllers: Pulse Width Modulation (PWM) and Maximum Power Point Tracking (MPPT). MPPT controllers are more efficient and are better at extracting maximum energy from solar panels under various environmental conditions. Charge controllers also help protect the system from battery discharge beyond safe levels and can adjust charging rates depending on battery temperature, thus prolonging battery life.

Function: Regulates the voltage and current from the solar panels to safely charge the battery and prevent overcharging.

Battery Storage:

Battery storage is used to store the electricity generated by solar panels for later use when there is no sunlight, such as during the night or on cloudy days. The stored energy can be used to power electric vehicles (EVs), appliances, or other devices. Common types of batteries used in solar systems include lithium-ion, lead-acid, and newer technologies like solid-state batteries. Lithium-ion batteries are often favored for their high energy density, longer life, and lighter weight. Battery storage allows users to be more energy-independent, reducing reliance on the electrical grid. It also helps to balance supply and demand, ensuring a continuous power supply even when solar generation is low.

Function: Stores excess energy generated by the solar panels for use during periods of low sunlight or at night, ensuring a constant power supply for charging the EV.

Microcontroller:

A microcontroller is a small, low-power computing device that plays a key role in managing and automating the various components of a solar energy system. It monitors the performance of the solar panels, charge controller, and battery storage, ensuring they operate efficiently. The microcontroller can also manage the wireless power transfer system and regulate when and how the electric vehicle (EV) is charged. By processing data from various sensors and inputs, the microcontroller can optimize the system's performance, adjusting charging rates or providing alerts for maintenance or faults. It acts as the "brain" of the system, coordinating operations, and enabling smart features like remote monitoring and control.

Function: Acts as the control unit for the entire system. It monitors the charging process, manages energy flow, and interfaces with the user interface to provide real-time information.

Wireless Power Transfer (Transmitter Coil):

Wireless power transfer (WPT) is an innovative technology that allows electricity to be transmitted without physical connectors, using electromagnetic fields to transfer energy between a transmitter and a receiver. The transmitter coil generates an electromagnetic field, which is captured by the receiver coil, converting it back into usable electrical energy. This method of charging is particularly useful for electric vehicles, as it eliminates the need for plugging in cables, making the charging process more convenient. WPT can also reduce wear and tear on charging ports. Although WPT technology is still developing, it shows great promise for making charging systems more seamless and user-friendly, particularly for EVs, smartphones, and other portable devices.

Function: Generates a magnetic field for inductive charging. The microcontroller activates the transmitter coil when the vehicle is aligned with the charging pad.

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Electric Vehicle:

Electric vehicles (EVs) are powered by electricity stored in rechargeable batteries rather than by an internal combustion engine. These vehicles are more energy-efficient and produce no tailpipe emissions, making them an environmentally friendly alternative to traditional gasoline-powered vehicles. EVs can be charged using power from the grid or from renewable sources like solar energy. The battery in an EV Typically lasts between 8 to 15 years, depending on factors like usage and charging habits. With advancements in battery technology, EVs are becoming more affordable, with improved ranges and faster charging times. Additionally, the integration of wireless charging technology into EVs offers a more convenient way to keep them charged, without the need for cables or physical connections.

Function: Equipped with a receiver coil that captures the magnetic energy transferred from the transmitter coil and converts it back into electrical energy for charging the vehicle's battery.

VII. METHODOLOGY

Solar Panels, Batteries, Transformers, Regulator Circuits, Copper Coils, Ac To Dc Converters, Atmel Controllers, And LCD Displays are all used in the system's construction. The method shows how electric vehicles may be charged while travelling down the road, doing away with the need to pull over. Through the use of a charge controller, the battery is powered by the solar panel. DC electricity is fed into and stored by the battery. Now that the DC power is ready for transmission, AC conversion is required. A transformer is used to convert the power to AC, and regulator circuitry is used to regulate it. The copper coils that are utilized for wireless energy transmission are now powered by this energy. Additionally, a copper coil is installed underneath the electric car. Energy is transmitted from the transmitter coil to the EV coil when the car is driven across the coils.

Please take note that the energy is still induced into this coil as DC current. to enable use in charging the EV battery, we now convert this back to DC.to convert it back to DC current, we employ circuitry for AC to DC conversion. The input voltage is now also measured by an Atmel Microprocessor, and the results are shown on an LCD screen.

7.1.1 Simulation Diagram

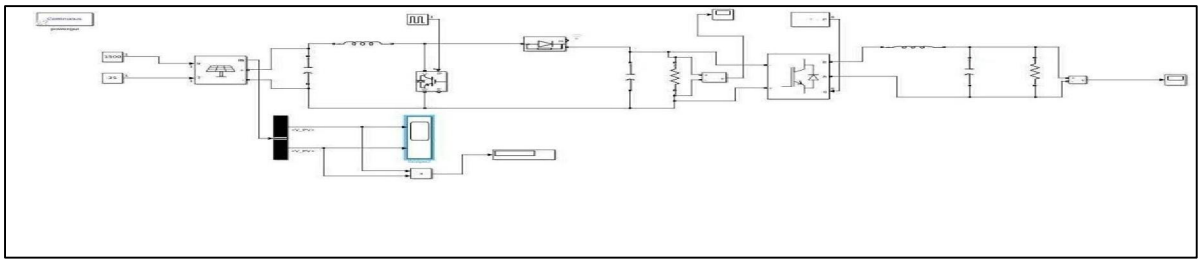

Fig 7.1 Simulation Diagram of Solar Based EV Charging System

7.1.2 Component Specifications are given below:-

Solar Panel

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Function: The solar panel is responsible for capturing sunlight and converting it into electrical energy through the photovoltaic effect. This energy is in the form of direct current (DC). The efficiency of the panel and its power output depends on the type and quality of the panel.

Types:
Monocrystalline: Known for higher efficiency and longer lifespan.
Polycrystalline: More affordable but slightly lower in efficiency compared to monocrystalline panels.
Key Points: The higher the wattage, the more power it can generate. A 300W panel can generate 300 watts of power per hour under optimal conditions.

VIII. EXPERIMENTAL RESULTS/OUTPUT

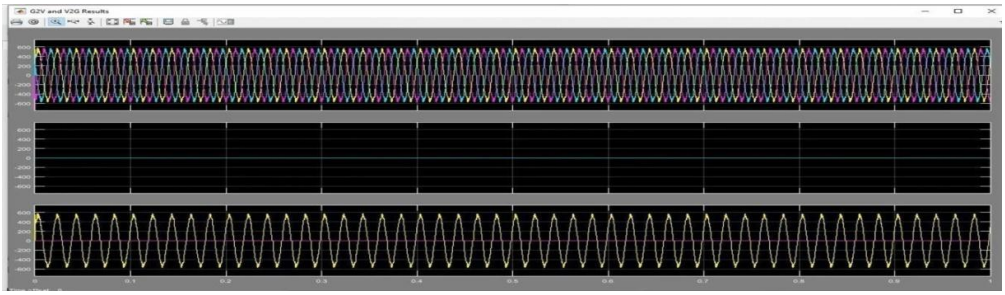

Fig 8.1 Simulation Output of Solar Based EV Charging System

IX. CONCLUSION

Currently, electric batteries are not the most popular choice for a battery nor are they anywhere near being the common used in cars on the road. Solar based electric vehicle charge system has been designed and tested in MATLAB Simulink tool successfully. MATLAB version.

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