A Review on Wireless Charging for ElectricVehicles

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***Abstract*— Energy is available in various forms from different natural sources such as solar energy, nuclear energy and chemical energy of fuels. The paper gives wireless charging techniques for electrical vehicle using solar energy. The fuel existing cars produces noise, air pollution and it produces major effects on an environment. But the wireless charging technology overcomes this pollution problems. Wireless power Transmission is very reliable, efficient, noiseless and pollution free technology. WPT is popular and gaining technology finding its application in various fields. It uses the principle of mutual inductance.**

Keywords*— *WPT-Wireless Power Transmission, EV-Electrical Vehicles, IPT-Inductive Power Technology

I. Introduction

Oil crises is eminent all over the world. As know that coal mines are shortage. In this scenario, it is necessary to shift the axis from non-renewable sources to renewable resources. The renewable sources are available in different forms like solar energy, wind energy, tidal energy, geo-thermal energy, and many forms are available in nature. Renewable energy sources are used to meet the peek load demand with the conventional source. The fuel cost of renewable energy source is less. Transportation system play a vital role in this modern era. At the same time, it accounts for about 27% of the carbon emission is crucial as it increases global warming to an alarming state. Global warming is threat to human life, at the same time, it leads to drastic changes in the climate Electric vehicles are introduced for today world, as it is thriving to use day by daynew technology everywhere.

The transfer of power is based on the principle of electromagnetic induction. The variable flux in primary coil links the secondary coil kept at some distance and hence emf is induced in the secondary coil. Inductively coupled power transfer is most widely used method for short distances. Compensator plays as important role in both the primary side and the secondary side. The compensator consists of AC capacitors tuned in to resonate with the inductance at the supply frequency. The compensator removes the harmonic in the primary and secondary coil.

The consequences of wired charging of Electrical vehicles and Traditional engine vehicles are:

- **Idle Power Draw:** When the charging process is complete, there might still be some power consumed to maintain the charging infrastructure resulting in a small amount of wasted energy.
- **Battery Efficiency:** The battery itself can have efficiency losses during charging and discharging.
- **Energy Source Impact:** The environmental benefits of wired EV charging depend on the energy source. If the electricity used for charging primarily comes from fossil fuels, the overall environmental impact may be lesspositive.
- **Heat Dissipation:** As the battery charges, it can generate heat, leading to energy loss. This is more pronounced in fast charging, as more power is delivered in a shorter time.
- **Higher Emission:** Petrol or diesel vehicles emit higher levels of pollutants and greenhouse gases than electric vehicle, contributing to air pollution and climate change.
- **Resistance in cable:** As electric current flows through the charging cables, there is a resistance that generates heat and reduces the efficiency of power transfer. Thicker cables can reduce the loss.

The objectives of wireless charging for electric vehicles are:

i. Maximize the efficiency of energy transfer from solar panel to the electric vehicle through the inductive power transfer. Minimize the energy losses in the charging process.

ii. To encourage more user to adopt electric vehicles by simplifying the charging process and making it more user friendly.

iii. Wireless charging with solar energy and inductive power transfer contributes to more sustainable and efficient future for electric vehicle charging.

II. WIRELESS ELECTRIC VEHICLE CHARGING SYSTEM

Schematic for our project: When the sun shines, the first solar panel produces up to 12V. The generated voltage is passed to a bridge rectifier to stabilized the voltage. When there is enough sunlight in the environment, LDRs have high resistance path, allowing current to flow through the grid or battery to the transmit coil. The battery charges and stores energy. A wireless transmitter connected to the battery sends the generated magnetic field around the coil. For transmission, the transmitter circuit converts DC to AC. This creates a magnetic field. A voltage senser is connected to the battery to display the battery and solar power voltage. The receiving coil produces a magnetic field and the voltage is in AC form. It converts AC to DC and stabilizes the voltage. This voltage is applied to the car battery to store and charge the energy. The LCD display shows the remaining battery power. The system uses solar panels, batteries, transformers, regulator circuits, copper coils, AC-DC converters, Atmega controllers and LCD displays to develop the system. A solar panel is used to power the battery via a charge controller. The battery is charged and storing DC power.

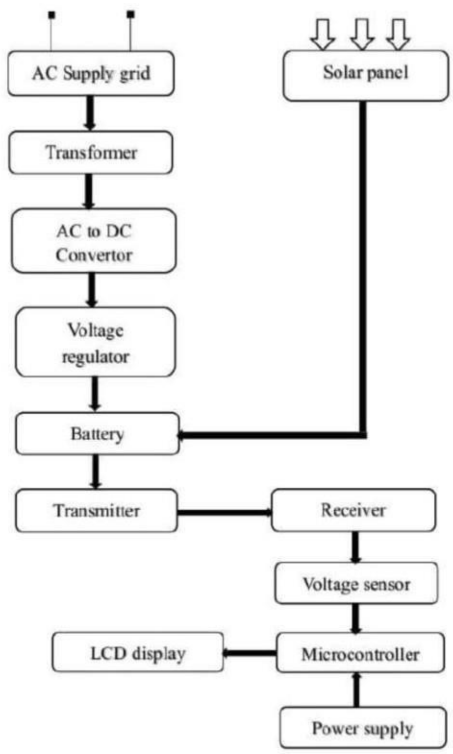

Figure 1: Block diagram of solar wireless electric vehicles charging system.

To transmit electricity, DC must be converted to AC. For this purpose, we use a transformer. Current is converted to a AC using a transformer and regulated using a regulator circuit. Copper coils is also installed under EV. As the vehicle drives over the coil, energy is transferred from the transmitter coil to the EV coil. It also uses an Atmega microcontroller to measure the input voltage and display it on the LCD display.

III. Literature Review

Spoorthi B S, Hemavarna, G Ramya, Hafsa Aiman and Esther A Chang [1] proposed a wireless energy transfer through the inductive coupling between transmitting and receiving coil to charge the vehicles battery. This helps the user to travel long distance at efficient speed and consumes less power. This system uses solar panel to produce the voltage, battery to charge and store the energy, transmitter to send generated magnetic field around coil and receiver to receive it, Arduino UNO and 16X2 LCD to display the voltage and transformer to convert the AC to DC. This proposed method maximizes the efficiency of charging. In the suggested future work, to focused on portable electric vehicle chargers that uses renewable energy to speed up charging and to introduce a new service for long distance travelers with electric vehicles by using hybrid drive system.

Ayush Sen, Bhuvan Sharma, Darshan Ranka, Drishti Gupta and Yusuf Sharif [2] developed a dynamic electric vehicle charging system form solar energy. This system reduces the time required to wait at charging station. This charging system can be implemented in the travel routes, traffic signal and bus station. The system uses both static and dynamic charging. In SWCS the primary coil is usually installedbelow the electric vehicle front, back or centre. The is converted from AC to DC using power converters and it transferred to the battery bank. This reduces power transmission losses, improves the utilization rate of renewable energies. This system reduces the need of transmission wire, fuel consumption and rid of hardware components wear and tear.

Gubbi J, Buyya R, Marusic and Palaniswami [3] offer an article in Future Generation Computer Systems titled “Internet of Things (IoT), A vision, architectural elements, and future directions”. The IoT and its potential effects on a number of applications, such as the integration of smart grid technology and the charging of electric vehicles, are discussed in further details in the article. With technology improving and electric vehicle incorporation into smart grids, it is essential to comprehend the IoT and how it relates to change the system. This study provides a broader view on the Internet of Things and electric car charging, even thought is not unique to solar wireless electric vehicle charging systems. Grant Covic and John Boys [4] offers an article named "Wireless Charging for Electric Vehicles”, The research seeks to enhance wireless charging for electric vehicles (EVs) for increased convenience and widespread adoption, addressing challenges associated with traditional plug-in methods. The methodology involves evaluating the present state of wireless charging technology, focusing on safety features and industry-wide standardization initiatives. The research also explores efficient design considerations for primary and secondary charging components. The ultimate aim is to streamline EV charging, alleviate range concerns, and contribute to cleaner urban environments. Future research will center on advancing technology for inductive power transfer (IPT) roadways, tackling the complexities of designing durable and cost-effective systems for dynamic charging applications. Furthermore, there will be a careful examination of the trade-off between powered city sections and DC fast charging, aiming for a well-balanced and effective wireless charging infrastructure.

Rakhi Kamra, Monu Malik and Jagriti Krishnan [5] offers an publication named “Wireless Charging in Electric Vehicles”. This research investigates wireless charging advancements, focusing on electric vehicles (EVs). The paper comprises three sections: the first covers wireless charging forms, terminology, and EV techniques; the second includes a small project on static wireless EV charging; and the third explores diverse industry applications, with potential dynamic charging extension. The methodology involves analyzing wireless charging forms, a practical project, and addressing challenges like financial investments, limited mobility of charging pads, misalignment, power losses, and radiation risks. The LED activation in the project indicates success. The applications section highlights innovative uses, such as Norway's wireless taxi charging and the Qi standard adoption. The research aims to provide insights into wireless charging and its potential future developments.

Mr. G Madhusagar Babu, Ms. A. Jahnavi, Mr. D.V.V. Prasad, Mr. K. Rakesh and Mr. G. Madhava Satya Sai Kumar [6] introduces a publication called "Solar wireless electric vehicle charging station”. This paper advocates for a shift to renewable energy, focusing on electric vehicles (EVs) in the face of global oil crises and coal shortages. The objective is to explore wireless power transmission (WPT) as an alternative for EV charging, addressing existing challenges. The methodology involves examining renewable energy benefits, emphasizing EV advantages, and proposing wireless charging technologies. The study also reviews semiconductor advancements and explores auto-charging systems for a reliable, wire-free, and sustainable EV charging solution.

Sally Kinya, Dedan Kimathi [7] publishes an publication called “Wireless Charging of Electric Automobiles in Africa: Opportunities and Challenges” This study explores the feasibility of wireless charging for electric vehicles (EVs) in Africa, given the region's unique challenges such as limited infrastructure and financial constraints. The objective is to analyze the potential benefits and drawbacks of wireless charging, considering its ability to overcome the hurdles associated with traditional EV charging methods. The methodology involves an examination of existing literature and data sources since no primary survey was conducted. The study assesses the current state of EV infrastructure in Africa, weighs the advantages and disadvantages of wireless charging, and outlines key implementation steps. By addressing the concerns of infrastructure, finance, and technology, the research aims to provide valuable insights for decision-makers and industry stakeholders, promoting wireless charging as a viable solution for eco-friendly mobility in Africa.

Abinand D, Deepak M, Maaz Ahmed, and Phanindar Ravi Parimi [8] present a comprehensive exploration of wireless charging for electric vehicles (EVs) in the International Research Journal of Engineering and Technology (IRJET), June 2020. The paper scrutinizes both static and dynamic charging systems, emphasizing the efficiency and practicality of inductive wireless power transfer. Through a comparative analysis of various wireless power transfer methods, the authors evaluate their characteristics and suitability for EV charging applications. The discussion extends to practical scenarios, envisioning the integration of wireless charging in electric cars, public transportation, and electric taxi fleets. While highlighting the promising trajectory of wireless EV charging, the paper addresses potential challenges related to efficiency and health concerns, offering valuable insights into the dynamic landscape of sustainable transportation.

Naoui Mohamed, Flah Aymen, Mohammed Alqarni, Rania A. Turky, Basem Alamri, Ziad M. Ali and Shady H.E. Abdel Aleem presents a groundbreaking wireless charging system for electric vehicles, featuring two receiver coils [9]. The system addresses challenges in conventional electric vehicle charging, allowing dynamic charging during vehicle motion. A novel mathematical model enhances power transfer, validated through experimental tests. The study explores key components, including compensation topologies and coil designs. It also considers electric vehicle and battery models, acknowledging the evolving landscape of energy storage. Future directions include refining control mechanisms and comparing the proposed dual-receiver solution with alternatives. The study highlights the potential integration of renewable energy sources, such as solar photovoltaic systems, for a more sustainable wireless recharge tool.

Yogesh A.M and Dr. Radhakrishna K.R. [10] conduct a thorough investigation into the impediments facing widespread electric vehicle (EV) adoption, particularly in densely populated nations like India. The authors meticulously outline the shortcomings of conventional charging methods and propose an innovative remedy by integrating In-wheel Wireless Power Transfer (WPT) systems alongside the adoption of Graphene batteries. Their study critically evaluates the limitations of traditional conductive charging, emphasizing concerns related to air gaps, coupling efficiency, and electromagnetic compatibility. The proposed In-wheel WPT systems stand out as a promising solution, effectively addressing these challenges. Additionally, the incorporation of Graphene batteries is advocated for their superior characteristics, such as high porosity, increased surface area, lightweight nature, and rapid charging capabilities. The paper delves into the principles and applications of static and dynamic charging systems, envisioning their deployment in diverse settings, including parking areas, commercial buildings, and roadways. By offering a comprehensive perspective, the authors position their proposed technologies as transformative forces poised to revolutionize the EV landscape. These advancements not only mitigate current challenges but also promote efficiency, sustainability, and cost-effectiveness, marking a significant stride toward the future of electric transportation

Sanjana Bhalekar, Shivtei Patil, Kapil Janokar, Swati Sonwar and Mina Vagha [11] have delved into the realm of wireless charging for electric vehicles, aiming to revolutionize the existing infrastructure. Their study focuses on the application of inductive power transfer (IPT) and capacitive power transfer (CPT) techniques, opting for IPT due to its efficacy. The researchers highlighted the fundamental principle of wireless charging, drawing parallels with traditional transformers. They emphasized the significance of wireless power transmission (WPT) in addressing the limitations of conventional plug-in charging stations, which they argued are less effective, time-consuming, and space-intensive. The study scrutinized the challenges, particularly the issue of coil alignment, and presented a comprehensive block diagram illustrating the essential components for wireless charging, including rectifiers, high-frequency inverters, transmitter and receiver coils, low-pass filters, and a DC-DC converter. Despite acknowledging efficiency challenges, the authors anticipate their project to contribute to the advancement of electric vehicle charging infrastructure, particularly emphasizing the potential of dynamic wireless chargers for seamless charging while in motion.

Yash Baviskar, Madhavi Patil, and Sandeep Ushkewar present an innovative wireless charging solution for electric vehicles (EVs) in their paper [12]. Addressing the challenges of conventional plugged-in charging, the authors emphasize the adverse effects of heat losses and the limitations of current cooling systems in EVs. They advocate for inductive wireless power transmission, citing its advantages in minimizing heat production during charging and improving battery life and efficiency. The authors delve into the types of wireless charging, with a focus on inductive wireless charging systems (IWC). They explore the fundamental principles of IWC, including resonant frequency, quality factor, and mutual inductance, providing a comprehensive understanding of the technology. The literature survey underscores the potential growth of the global wireless EV charging market, predicting a significant CAGR. The authors also identify future research areas, such as battery range concerns and standardization of charging capacities, indicating the evolving landscape of wireless charging in the electric vehicle sector.

IV. Conclusion

In conclusion, the paper underscores the urgency of transitioning from non-renewable to renewable energy sources, with a particular focus on wireless charging methods for electric vehicles (EVs) utilizing solar energy. By advocating for wireless power transmission (WPT) based on the principle of mutual inductance, the paper emphasizes the technology's reliability, efficiency, and pollution-free attributes. Detailing the drawbacks of traditional wired charging systems, it outlines the objectives of wireless charging, aiming to maximize energy transfer efficiency, encourage EV adoption, and contribute to a sustainable future. The proposed wireless charging system integrates solar panels, batteries, and advanced circuitry, presenting a simplified, user-friendly, and environmentally conscious approach to EV charging. Overall, the paper anticipates the transformative potential of wireless charging technologies in fostering a greener and more efficient landscape for electric transportation

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