WWW.IJRPR.COM

International Journal of Research Publication and Reviews

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

DYNAMIC WIRELESS CHARGING FOR ELECTRIC VEHICLE WITH MULTIPLE ENERGY SOURCES

R. Nagasai[1], T. Vasu[2], Y. Kiran Naidu[3], P. Uma maheswara Rao[4], S. Lavanya[5], S. Raja varma[6], K. Harika[7]

[1,2,3,4,5,6,7]Department Of Electrical And Electronics Engineering, GMRIT, Rajam, Vizianagaram, Andhra Pradesh, India.

ABSTRACT :

Addressing problems like range anxiety, lengthy charging periods, and reliance on fossil fuels is crucial as electric cars (EVs) proliferate. By enabling EVs to charge while driving, Dynamic Wireless Charging (DWC) presents a viable alternative to frequent stops and big batteries. This study suggests a smart DWC system that is fueled by a variety of renewable energy sources, including grid-connected energy storage, wind turbines, and solar panels. Advanced power electronics, wireless energy transfer via inductive coils in the road, and a hybrid energy management algorithm that modifies power distribution in real-time according to traffic, vehicle demands, and energy availability are all part of the system. The concept promotes a more resilient and sustainable transportation infrastructure by lowering carbon emissions and dependence on the grid. The design's viability is validated by simulations and prototype testing, which demonstrate improved energy efficiency, reliable charging, and environmental advantages. Future intelligent and environmentally friendly mobility solutions are made possible by this multi-source DWC strategy.

Keywords: Dynamic Wireless Charging (DWC), Renewable Energy (Solar, Wind), Grid-connected Energy Storage, Wireless Power Transfer, Carbon Emission Reduction.

I.INTRODUCTION

Electric vehicles (EVs) are becoming a significant alternative to fossil fuel-based transportation as the globe transitions to a more sustainable economy due to their increased energy efficiency, reduced emissions, and lower operating costs. Wider acceptance is nevertheless hampered by problems such a lack of charging stations, long charging times, and range anxiety. Dynamic Wireless Charging (DWC) has made it possible to charge EVs while they are in motion. By using electromagnetic induction or magnetic resonance, coils under the road can wirelessly send electricity to receivers inside the vehicle. This is especially beneficial for long trips and commercial fleets since it can greatly extend driving range and reduce the need for recharge stops. Combining many energy sources is essential to improving DWC's efficiency and environmental friendliness. Instead than only relying on the grid, renewable energy sources like solar panels and wind turbines can be used. In windy regions, wind turbines can generate electricity, while solar panels can be placed next to roads or in open areas. When renewable energy sources are not enough, grid electricity can take over, with a step-down autotransformer regulating the voltage levels to ensure appropriate levels. This hybrid approach reduces grid pressure, ensures a steady power supply, and makes EV charging more ecologically friendly. Smart grids and Internet of Things technology can optimise power distribution by using data from energy sources and vehicles, enabling real-time energy flow control. This leads to enhanced efficiency, decreased energy waste, and improved grid stability.

II. SYSTEM DESIGN

Explain the dynamic wireless charging system's design and optimisation, taking into account the control systems, power electronics, and coil design.
Coil design: Coil design and optimisation, including material, size, and form, for effective power transfer in transmitters and receivers.
Power electronics: For effective power conversion and transfer, power electronic components like rectifiers and inverters are chosen and designed. We employed mosfets and bridge rectifiers in our project.

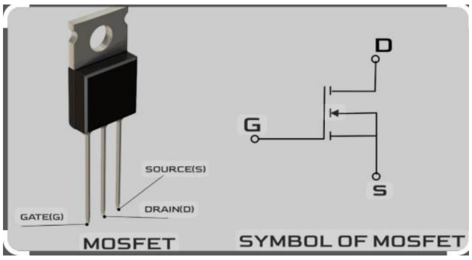

Figure 1: Mosfet symbol

Control systems: Design and deployment of dynamic wireless charging control systems with energy management, safety measures, and power flow control.

Energy storage: For effective energy storage and release, energy storage technologies like batteries and supercapacitors must be integrated and managed.

Figure 2: Rechargeable Battery

III. MODELING AND ANALYSIS

System efficiency optimisation, which includes maximising power transfer efficiency and minimising energy losses. Power transfer optimisation is the process of optimising power transfer, which includes minimising power transfer fluctuations and increasing power transfer rate. System cost optimisation includes maximising system longevity and minimising component costs. Safety optimisation is the process of maximising system dependability and minimising the risk of electrical shock.

Efficiency Optimization:

Through the reduction of energy losses and the enhancement of power transfer efficiency, efficiency optimisation aims to improve system performance. It guarantees sustainable energy use for electric vehicles by lowering resistive losses, electromagnetic interference, and needless energy dissipation. Achieving maximum efficiency is facilitated by methods including enhanced coil design, adaptive control schemes, and highly conductive materials. In order to accommodate different vehicle speeds and road conditions, the system dynamically modifies power transmission rates. Furthermore, integrating intelligent energy management algorithms enhances power flow and promotes dependable operations.

Power transfer optimization

Optimising power transfer seeks to maximise and stabilise the power delivery rate during dynamic wireless charging. It entails controlling voltage levels, reducing oscillations, and guaranteeing steady energy flow in spite of changes in the environment or in moving vehicles. The quality of power transfer is enhanced by methods including resonant coupling, frequency tuning, and load balancing. Power delivery disruptions can be avoided by the smooth transitions between charging stations made possible by multiple-source integration.

Cost Optimization:

When designing dynamic wireless charging systems for electric vehicles, cost optimisation strikes a compromise between price and endurance. By using creative designs, reasonably priced materials, and scalable production processes, it lowers the initial component costs. Durable parts and low maintenance needs increase the system's lifespan and result in long-term cost savings. Modular designs are one tactic for simple upgrades and economical repairs. By increasing system efficiency and incorporating renewable energy sources, lifecycle cost reduction is accomplished, which lowers operational costs. In the end, cost optimisation makes the technology financially feasible, encouraging broad use and advancing environmentally friendly transportation options without sacrificing functionality or quality.

Safety Optimization

Safe and dependable operations in dynamic wireless charging systems are guaranteed by safety optimisation. By using sophisticated insulation, grounding, and fail-safe devices, it reduces the risk of electrical shock. Real-time monitoring is incorporated into the system to detect faults and take precautions against short circuits or overheating. Safety standards are further raised by reliability enhancement strategies including redundant system designs and strong material selection. Furthermore, electromagnetic compatibility ensures adherence to health rules by protecting against dangerous radiation exposure.

IV. MULTIPLE ENERGY SOURCES INTEGRATION

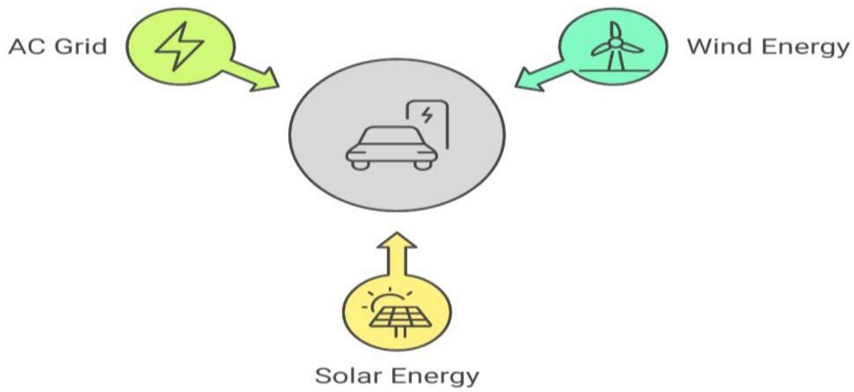

Figure 3: Different energy sources

Energy Source Selection:

For dynamic wireless charging systems, choosing an energy source is essential to guaranteeing a steady and continuous power supply. Integration of several sources, including grid power, wind, and solar, can improve efficiency and dependability. Smooth switching between sources is made possible by hybrid energy models, which maximise use according to demand and availability. In real time, sophisticated algorithms identify the most efficient source, reducing reliance on a single energy source. While preserving cost-effectiveness, using renewable resources lessens the impact on the environment.

Energy Management:

Energy management techniques provide energy storage and regulated release to preserve system stability while guaranteeing the seamless operation of various energy sources. In order to optimise energy flow for real-time charging requirements, smart storage solutions balance excess power. Adaptive algorithms prevent inefficiencies and power waste by dynamically controlling the allocation of energy. By reducing charging variations, battery management systems increase dependability and lifespan. Predictive load balancing is included to provide uninterrupted, steady electricity to cars.

V.CONCLUSION

Powered by multiple renewable energy sources, the proposed Dynamic Wireless Charging (DWC) system offers a groundbreaking solution to some of the most significant problems facing electric vehicles, such as distance anxiety, inadequate charging infrastructure, and dependence on fossil fuels. By integrating solar, wind, and grid-connected energy storage, the system ensures a consistent, efficient, and ecologically friendly power source. Inductive coils installed in highways, optimised power electronics, and real-time control algorithms provide smooth energy transmission to moving automobiles, enhancing system performance and user convenience. The design uses advanced optimisation approaches that focus efficiency, power transmission, cost, and safety to deliver a reliable, scalable, and sustainable charging infrastructure. Simulation and prototype tests validate the system's ability to maintain consistent energy flow, reduce carbon emissions, and enable long-distance transport without frequent stops or substantial battery requirements. Ultimately, by establishing the foundation for the next generation of smart mobility, this multi-source DWC approach significantly advances the objective of resilient, intelligent, and sustainable transportation systems.

VI. REFERENCES

[1] Bhat, P. K., Wu, Z., & Chen, B. (2025). Long trip charging planning of battery electric vehicle considering vehicle waiting time forecast at fast charging stations: A Mixed-Integer Dynamic Programming approach. IEEE Access, 1. https://doi.org/10.1109/access.2025.3552730

[2] Aldhanhani, T., Abraham, A., Hamidouche, W., & Shaaban, M. (2024). Future trends in Smart Green IOV: Vehicle-toEverything in the era of Electric Vehicles. IEEE Open Journal of Vehicular Technology, 5, 278– 297. https://doi.org/10.1109/ojvt.2024.3358893

[3] Prasanthi, A., Shareef, H., Errouissi, R., Murugesu, G. V., & Asna, M. (2024). Optimal Sizing and dynamic energy source Characteristics of Hybrid Electric Vehicles: A Comprehensive Review and Future Directions. IEEE Access, 12, 44695– 44729. https://doi.org/10.1109/access.2024.3380464

[4] Benaitier, A., Krainer, F., Jakubek, S., & Hametner, C. (2024). A modular approach for cooperative energy management of hybrid electric vehicles considering predictive information. IEEE Access, 12, 60588– 60600. https://doi.org/10.1109/access.2024.3395019

[5] Shanmugam, Y., R, N., Vishnuram, P., Bajaj, M., AboRas, K. M., Thakur, P., & Kitmo, N. (2022). A Systematic Review of Dynamic wireless charging System for electric transportation. IEEE Access, 10, 133617–133642. https://doi.org/10.1109/access.2022.3227217

[6] Kim, K., Kim, H., Seo, D., & Choi, J. (2022). Magnetically decoupled modular Coil array for dynamic wireless power transfer with magnetic beamforming. IEEE Access, 10, 42121–42140. https://doi.org/10.1109/access.2022.3168353

[7] Chen, L., Liao, Z., & Ma, X. (2020). Nonlinear model predictive control for Heavy-Duty hybrid electric vehicles using random power prediction method. IEEE Access, 8, 202819–202835. https://doi.org/10.1109/access.2020.3036644

[8] Nguyen, D. M., Kishk, M. A., & Alouini, M. (2020). Modeling and Analysis of dynamic charging for EVs: A Stochastic Geometry approach. IEEE Open Journal of Vehicular Technology, 2, 17–44. https ://doi.org/10.1109/ojvt.2020.3032588

[9] Hwang, I., Jang, Y. J., Ko, Y. D., & Lee, M. S. (2017). System optimization for dynamic wireless charging electric vehicles operating in a Multiple-Route environment. IEEE Transactions on Intelligent Transportation Systems, 19(6), 1709 1726. https://doi.org/10.1109/tits.2017.2731787