STM JOURNALS

Journal of
Refrigeration, Air Conditioning, Heating and Ventilation

ISSN: 2394-1952
Volume 11, Issue 1, 2024
January—April
DOI (Journal): 10.37591/JoRACHV

http://techjournals.stmjournals.in/index.php/JoRACHV/index

Review JoRACHV

Solar Based Electric Vehicle Charging

Parnal Anil Gaikwad[1,*], Nakul Dipak Shirsale[2], R.U. Shekokar[3]

Abstract

The "Solar-Based Wireless Power Transmission Highways" project aims to revolutionize the way we generate and distribute electrical energy on highways. This innovative system harnesses solar energy through strategically placed solar panels along the highway, converting it into electricity. The electricity is then wirelessly transmitted to electric vehicles (EVs) passing overhead, enabling them to charge without the need for physical connections. This technology not only addresses the growing demand for sustainable transportation but also reduces greenhouse gas emissions by promoting the use of clean energy sources. The project's methodology involves the design and implementation of a solar-based wireless power transmission system, comprehensive testing, and the evaluation of its efficiency and environmental impact. The results demonstrate the feasibility and potential benefits of integrating solar-based wireless power transmission into our infrastructure, paving the way for a more sustainable and efficient future for transportation systems. Solar-based wireless power transmission highways are a new and innovative technology that has the potential to revolutionize the transportation industry. By using solar energy to generate electricity and wirelessly transmit it to electric vehicles, these highways could provide a clean, sustainable, and efficient way to power transportation.

Keywords: WPT, inductive coupling, magnetic resonance, radio frequency

INTRODUCTION

In an era marked by increasing environmental concerns and the urgent need to transition to sustainable energy solutions, the "Solar-Based Wireless Power Transmission Highways" project emerges as a pioneering endeavour at the intersection of renewable energy and transportation infrastructure. The global reliance on fossil fuels in the transportation sector has given rise to substantial greenhouse gas emissions and air pollution, necessitating innovative solutions to mitigate these environmental challenges. Electric vehicles (EVs) have emerged as a promising alternative, but their widespread adoption faces challenges, particularly in terms of charging infrastructure and range anxiety. This project addresses these challenges by introducing a novel system that combines solar energy harvesting with wireless power transmission to create a sustainable and efficient means of charging EVs [1-5].

By strategically deploying solar panels along highways and wirelessly transmitting the energy they generate to passing electric vehicles, this system not only promotes cleaner modes of transportation but also reduces the strain on grid infrastructure. Ultimately, the "Solar-Based Wireless Power Transmission Highways" project holds the promise of revolutionizing the transportation industry, making it more sustainable and reducing its impact on the environment. In today's rapidly evolving world, addressing the twin challenges of climate change and the increasing

***Author for Correspondence**
Parnal Anil Gaikwad
E-mail: parnalgaikwad@gmail.com

[1-2]Student, Department of Electronics & Telecommunication, Sinhgad College of Engineering, Savitribai Phule University, Pune, Maharashtra, India
[3]Professor, Department of Electronics &; Telecommunication, Sinhgad College of Engineering, Savitribai Phule University, Pune, Maharashtra, India

Received Date: April 25, 2024
Accepted Date: May 03, 2024
Published Date: May 17, 2024

Citation: Parnal Anil Gaikwad, Nakul Dipak Shirsale, R. U. Shekokar. Solar Based Electric Vehicle Charging. Journal of Refrigeration, Air Conditioning, Heating and Ventilation. 2024; 11(1): 27-32p.

demand for energy-efficient transportation systems has become paramount. The "Solar-Based Wireless Power Transmission Highways" project is a groundbreaking response to these challenges. It introduces a pioneering system that harnesses solar energy and employs wireless power transmission technology to charge EVs while they are in motion on highways [6-8].

METHODOLOGY

The methodology employed in the "Solar-Based Wireless Power Transmission Highways" project is a comprehensive and systematic approach that ensures the development of a sustainable, efficient, and reliable system. By taking into account the technical, environmental, regulatory, and safety aspects of the project, the methodology sets the foundation for the successful implementation and future scalability of this groundbreaking technology. The methodology of the "Solar-Based Wireless Power Transmission Highways" project extends beyond the key phases of design, implementation, testing, evaluation, and data analysis. It encompasses several additional facets that are crucial for the comprehensive development and deployment of the system [9-10].

Environmental Impact Assessment is an integral part of the project's methodology. This involves a thorough examination of the ecological consequences of the installation of solar panels and wireless power transmission technology within the highway infrastructure (Figure 1).

WORKING PROCESS

The solar panel will collect the energy from the sun and it will charge the battery through charge controller. The charge controller will ensure that our battery will not get overcharged. This battery stores Dc charge but for the transmission we need AC. For that purpose we need to convert DC to AC. For this conversion we have used inverter that will convert our battery's DC to AC. Now, this AC will be transmitted to the Copper coil (Transmitting coil) through a current controller.

The transmitting coil is placed under the road and the receiving coil is placed underneath the vehicle. For the transmission between two copper coil we have used a phenomenon called as "inductive coupling ". When the Electric vehicle will drive over this road (with the coil inside), there will be transmission of energy from transmitting coil to receiving coil i.e from road coils to vehicle coils. Here, the current through this coil is AC current. But note that for charging the EV's battery we need DC. Hence for that purpose we have used AC to DC converter that will give the DC output which will be used to charge the battery of vehicle. The ATMEGA microcontroller is al so used which is voltage sensing that will sense/measure the voltage and that voltage will be displayed on the LCD display.

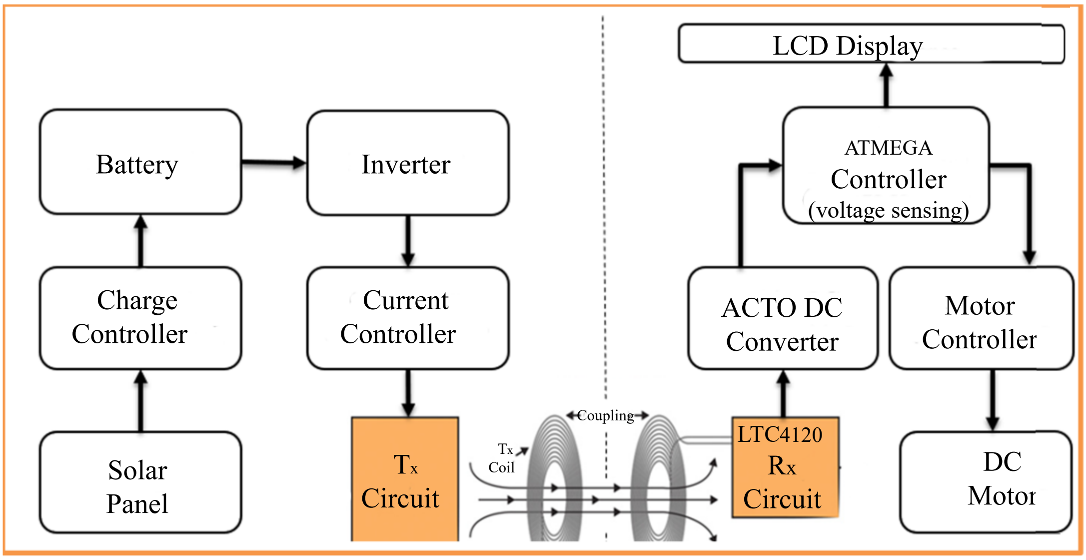


Figure 1. Block diagram of solar based EV charging.

TABLES AND FIGURES

1. *Solar Energy collection:* Solar panels are used to collect energy from the sun. This energy is then stored in batteries.
2. *Power Conversion:* The energy stored in the batteries is converted into a form that can be transmitted wirelessly. This is done using power converters.
3. *Power Transmission:* The converted power is transmitted wirelessly to EVs using a variety of techniques, such as inductive coupling and resonant coupling.
4. *Power Reception:* EVs receive the transmitted power using coils or other devices that are embedded in the road. This power is then used to charge the EV's battery (Figure 2).
    - A solar-based wireless power transmission highway could be built along a major interstate highway, allowing electric vehicles to travel long distances without stopping to charge.
    - A solar-based wireless power transmission highway could be built around a city, providing a convenient way to power electric buses and taxis (Table 1).
    - A solar-based wireless power transmission highway could be built in a remote mining region, providing electricity to the mining operations and the surrounding community.
    - A solar-based wireless power transmission highway could be built on a military base, providing a secure and reliable source of power for the base's operations (Table 2).

CALCULATIONS

To calculate the power generation and transmission for a solar-based wireless power transmission (WPT) highway with a 415-volt, 100-kwatt solar panel, you can follow these steps:Power Generation:

- Solar Panel Rating: 100 kwatts
- Solar Panel Voltage: 415 volts

- The power generated by a solar panel is given by the product of its voltage and current
- (P = V x I). You need to find the current (I) to calculate the actual power output.
- Assuming solar panel operates at its maximum power point (commonly denoted as the MPP, which is not always the case), you can find the current using the formula:

I = P / V
I = 100 kwatts / 415 volts
I ≈ 240 amps (A)

Table 1. Literature Survey.

	Year	Title	Key Findings
Li and Mi	2023[11]	A Review of Wireless Power Transfer for Electric Vehicles: Prospects to Enhance Sustainable Mobility	Wireless charging is a promising technology for electric vehicles, offering advantages such as convenience, safety, flexibility, and durability. However, challenges remain, including efficiency, cost, and standardization.
Mohammed and Jung	2022[12]	A Comprehensive Analysis of Wireless Charging Systems for Electric Vehicles	Wireless charging systems can be classified into inductive and resonant types. Inductive WPT systems are more mature and widely used, but resonant WPT systems offer advantages such as higher efficiency and longer power transfer distances.
Park et al.	2022[13]	A Critical Review on Wireless Charging for Electric Vehicles	Wireless charging is a promising technology for electric vehicles, but there are still some challenges that need to be addressed, such as efficiency, cost, and safety.
WiTricity	2022[14]	WiTricity Announces New 11 kW Dynamic Wireless Charging System	WiTricity has announced a new dynamic wireless charging system that can transfer power at up to 11 kW. This is a significant increase over the power transfer capabilities of previous wireless EV charging systems.

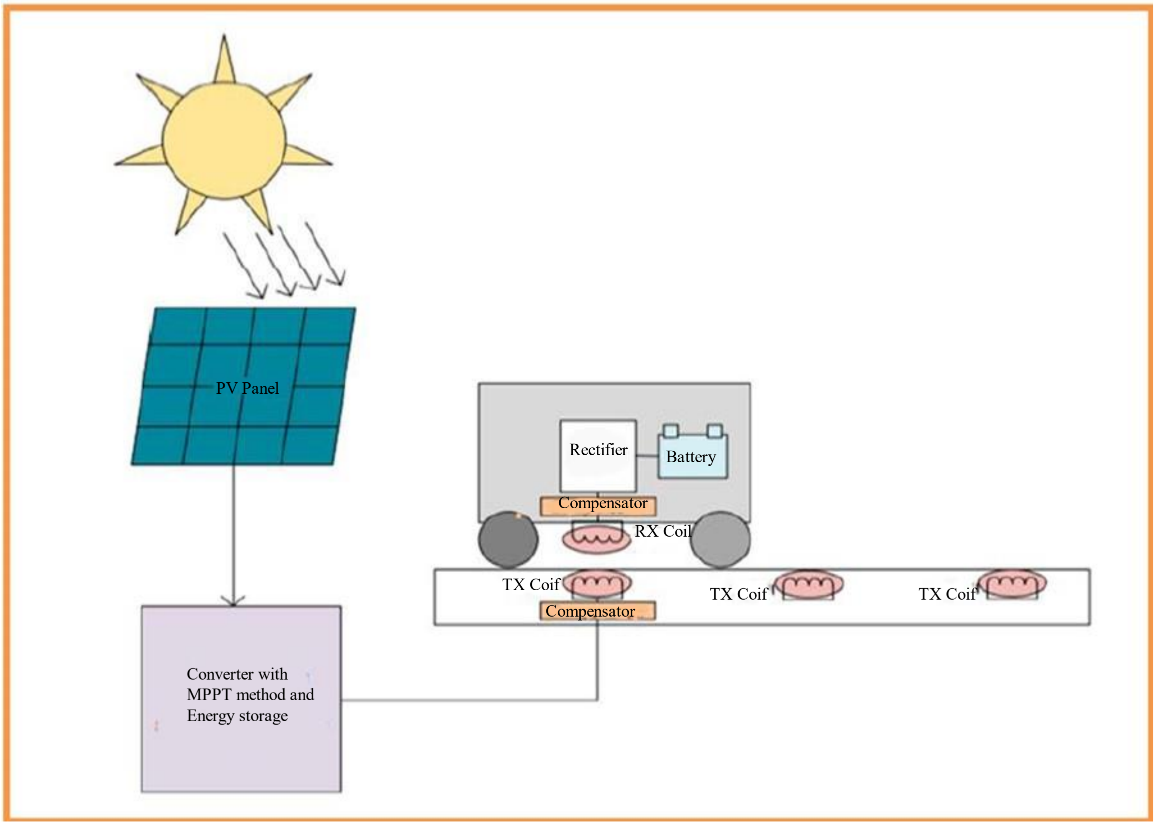
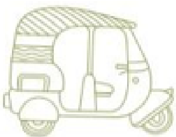
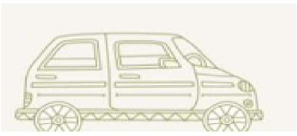


Figure 2. Visual representation for solar based EV charging.

Table2. Different vehicle with their battery voltages.

Vehicle Segment	Battery Capacity	Battery Voltage
 E-2W	1.2-3.3 kWh	48-72V
 E-2W (passenger/goods)	3.6-8 kWh	48-60V
 E-cars (1st generation)	21 kWh	72V
 E-cars (2nd generation)	30-80 kWh	350-500V

Daily Power Generation

- The daily power generation depends on the number of hours of direct sunlight.
- Let's assume an average of 5 hours of direct sunlight per day:
- Daily Power Generation = 240 A (current) * 415 volts (voltage) * 5 hours = 498 k watt-hours (kWh) per day.

Monthly Power Generation

- Assuming an average of 30 days per month:
- Monthly Power Generation = 498 kWh/day * 30 days = 14940 kWh per month.

Annual Power Generation

Similarly, for a year:
Annual Power Generation = 14940 kWh/month * 12 months = 179280 kWh per year.
Now, you have generated approximately 179280 kWh of power annually using 415volt, 100kwatt solar panel.

Wireless Power Transmission Efficiency

- The efficiency may vary due to various factors. For simplicity lets consider that the efficiency of wireless power transmission be 80%.
- Wireless Power Transmission Efficiency = 80% = 0.80 (as a decimal).

Actual Wireless Power Output

- Actual power transmitted wirelessly:
- Actual Power Output = Annual Power Generation * Wireless Power Transmission Efficiency
- Actual Power Output = 179280 kWh * 0.80 = 143424 kWh (annually).

With 415-volt, 100-kwatt solar panel and assuming 5 hours of sunlight per day, you can generate approximately 143424 kWh of wireless power annually. As mentioned earlier, this is a simplified calculation, and actual results may vary depending on several factors, including the efficiency of your specific wireless power transmission system and the location's sunlight conditions.

CONCLUSION

The "Solar-Based Wireless Power Transmission Highways" project represents a visionary endeavour at the forefront of the global transition to sustainable and efficient transportation systems. As we navigate the challenges posed by climate change, air pollution, and the depletion of finite energy resources, this project emerges as a beacon of innovation and hope. It envisions a future where highways not only serve as conduits for vehicles but also as dynamic sources of clean, renewable energy. The journey of this project, from its conceptualization to its comprehensive methodology, reveals the depth of commitment to making this vision a reality.

The "Solar-Based Wireless Power Transmission Highways" project is not just a testament to technological prowess but a promise of a cleaner, more efficient, and environmentally responsible future. It stands as a testament to the relentless spirit of innovation and the collaborative efforts of researchers, engineers, government agencies, and industry leaders who believe in the transformative power of sustainable transportation. With its potential to reduce greenhouse gas emissions, promote energy efficiency, and pave the way for cleaner, more sustainable transportation systems, this visionary initiative has the potential to revolutionize the way we think about energy, transportation, and the future of our planet. As we look ahead, the "Solar-Based Wireless Power Transmission Highways" project serves as an inspiration, guiding us towards a greener and more sustainable world.

WPT is a promising technology for charging EVs. It has the potential to eliminate the need for cumbersome charging cables and plugs, making it more convenient and efficient to charge EVs.

While there are still some challenges that need to be addressed, researchers are actively working to solve them. It is expected that WPT will play an increasingly important role in EV charging in the future.

REFERENCES

1. M. R. Islam, M. T. Iqbal, and M. K. Hannan, "Electric vehicle wireless charging systems and a review on wireless vehicle dynamics," Energies, vol. 11, no. 2,p.456, 2018.
2. C. Mi, S. Kang, J. Huh, and J. M. Park, "Design and analysis of an inductive power transfer system for electric vehicle charging applications," Energies, vol.12,no. 10,p. 1916, 2019.
3. S. Raval, A. Jain, and A. Khan, "A review on dynamic wireless power transfer for electric vehicles," in 2016 International Conference on Signal Processing, Communication, Power and Embedded System (SCOPES), 2016, pp. 1048-1052.Arne Sund.2015.
4. A. A. Arkadan, H. W. Ho, and M. A. Karim, "Wireless power transfer to an electric vehicle during its moving using series-series resonant converter," IET Power Electronics, vol. 8, no. 8, pp. 1461-1471, 2015.
5. Z. Chen, H. Liu, S. Chen, and C. C. Mi, "Dynamic wireless charging of electric vehicles: principles, standards, and trends," IEEE Electrification Magazine, vol.5, no. 1, pp. 33- 44, 2017.
6. S. Kim, S. Kim, and C. Kim, "A study on electric vehicle dynamic wireless charging system based on road surface segments," Energies, vol. 13, no. 13, p. 3325, 2020.
7. S. You, C. Mi, and L. Sun, "Recent advances in wireless power transfer via human movements for wearable and implantable devices," IEEE Access, vol. 8, pp. 123860- 123887, 2020.
8. Y. K. Song, C. Mi, and F. Du, "Optimal design of a series-series inductive power transfer system for on-road EV charging," IEEE Transactions on Power Electronics, vol. 32, no. 9, pp. 7167-7177, 2016.
9. S. Zhang, X. Li, S. Ji, and Q. Tang, "Dynamic charging for electric vehicles on the road: an overview," IEEE Transactions on Vehicular Technology, vol. 66, no. 8, pp. 6430-6442, 2017.
10. S. M. Perera, M. M. Rashid, and N. G. J. Fonseka, "Electric road vehicles: an overview of the concept, technology, and classification," IEEE Transactions on Vehicular Technology, vol. 68, no. 4, pp. 3016-3032, 2019.
11. Li, X., Zheng, F., Wang, H., Sun, Y., Dai, X., & Hu, J. (2023). A Simultaneous Power and Data transfer Method for Dynamic Wireless Charging Electric Vehicles. *IEEE Journal of Emerging and Selected Topics in Power Electronics*.
12. Mohamed, N., Aymen, F., Alharbi, T. E., El-Bayeh, C. Z., Lassaad, S., Ghoneim, S. S., & Eicker, U. (2022). A comprehensive analysis of wireless charging systems for electric vehicles. *IEEE Access*, *10*, 43865-43881.
13. Park, J., An, J., Han, K., Choi, H. S., & Park, I. S. (2022). Enhancement of cooling performance in traction motor of electric vehicle using direct slot cooling method. *Applied Thermal Engineering*, *217*, 119082.
14. Karthik, D. R., Bandi, M., Marati, N., Vaithilingam, B., & Karuppazhagi, K. (2022). Recent Trends and Technologies of Electric Vehicles and Their Wireless Charging Methods: A Review. *Smart Charging Solutions for Hybrid and Electric Vehicles*, 399-418.

