

# A SUSTAINABLE ENERGY APPROACH THROUGH SOLAR WIRELESS EV CHARGING SYSTEMS

Faraz Hussain, Keya Patel, Lakshayraj Singh Jhala, Rakesh Bairwa, Tejas Chouhan, Shruti Bhadviya

E-Mail Id: farazhussain@gmail.com

Department of Electrical Engineering, GITS, Udaipur, Rajasthan, India

**Abstract** - This paper examines the pivotal role of electric vehicles (EVs) in shaping a sustainable future by reducing carbon footprints in the transportation sector. With rising greenhouse gas emissions and the urgent need to combat climate change, EVs present a cleaner and more efficient alternative to internal combustion engine vehicles. The study analyzes recent data on emission reductions, technological advancements, and supportive policy frameworks that drive EV adoption worldwide. Beyond reducing carbon emissions, EVs contribute to urban sustainability by lowering noise pollution, improving air quality, and integrating with smart grids and public transport systems. Key challenges, including high upfront costs, limited charging infrastructure, and battery lifespan concerns, are explored alongside emerging solutions such as advanced battery technologies, recycling practices, and second-life applications. The findings underscore the transformative potential of EVs in advancing green mobility and achieving long-term climate goals.

**Keywords:** Solar energy, Wireless power transfer, Electric vehicles, Sustainable mobility, Green charging infrastructure, Renewable energy integration, Carbon emission reduction, Energy resilience.

## 1. INTRODUCTION

The rapid rise in electric vehicle adoption worldwide has led to an increasing demand for innovative and sustainable charging solutions. Traditional EV charging methods rely heavily on the power grid, which is still predominantly powered by non-renewable energy sources. A promising solution to this challenge is the integration of solar energy with wireless power transfer (WPT) technology for EV charging. This paper delves into the working principles, benefits, and potential applications of solar wireless EV charging systems, focusing on their contributions toward a greener and more energy-efficient future.

### 1.1 Problem Statement

EVs face challenges related to charging infrastructure and the dependency on non-renewable energy sources. There is a growing need for systems that can offer convenient, sustainable, and efficient charging alternatives.

### 1.2 Objectives of the Study

- To explore the feasibility of integrating solar energy and wireless charging technologies for electric vehicles.
- To evaluate the environmental and economic impacts of solar wireless EV charging systems.
- To identify the technological advancements and challenges associated with this integration.

## 2. LITERATURE REVIEW

In recent years, numerous studies have explored different facets of solar EV charging. The concept of wireless power transfer for EVs has been studied extensively, with a focus on reducing the need for physical connections between vehicles and charging stations.

### 2.1 Solar Energy for EV Charging

Solar energy offers an eco-friendly and renewable source for EV charging. It has the potential to reduce the carbon footprint associated with EVs by enabling them to run entirely on solar power, particularly in regions with high sunlight exposure. Previous studies show that solar-powered EV charging stations can be effective in both urban and rural settings.

### 2.2 Wireless Power Transfer for EVs

Wireless charging involves the transfer of power from a charging station to the vehicle without the need for physical connectors. This technology is based on electromagnetic induction or resonance, where energy is transferred between coils in the ground and coils in the vehicle. WPT technology has been under development for several years, with advances in power transfer efficiency and safety.

### 2.3 Solar Wireless Charging Systems

The integration of solar power with wireless charging systems for EVs is an emerging area of research. This combined system involves solar panels converting sunlight into electricity, which is then transmitted wirelessly to the EV. Studies highlight both the environmental benefits and technical challenges of such systems, including

efficiency losses and space limitations.

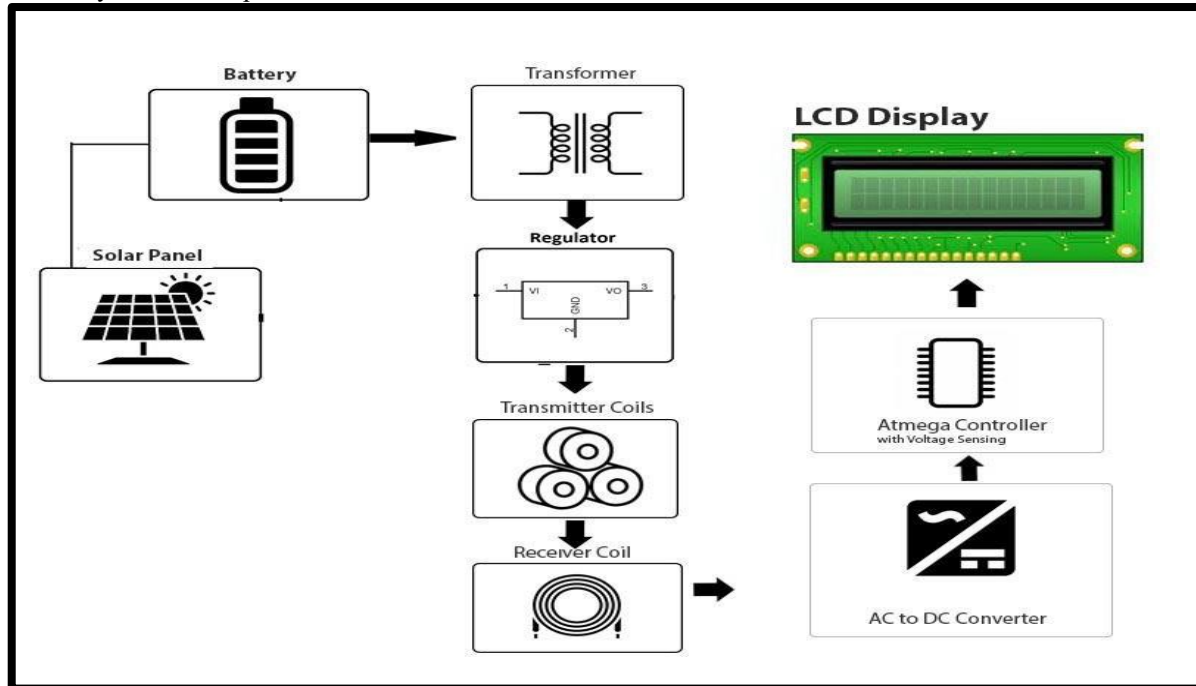


Fig. 2.1 Block Diagram of Wireless EV Charging

### 3. SYSTEM DESIGN AND WORKING PRINCIPLES

#### 3.1 Solar Panel Integration

The solar panels used in the system are designed to capture sunlight and convert it into electrical energy. These panels are often installed on rooftops, parking lots, or other open spaces where sunlight is abundant. The energy generated by the solar panels is then stored in batteries or fed directly into the wireless charging system.

#### 3.2 Wireless Power Transfer Technology

Wireless power transfer for EVs is typically achieved through inductive charging systems, where a primary coil in the ground generates a magnetic field that induces a current in the secondary coil within the vehicle. This technology eliminates the need for physical plugs and cables, making it more convenient for EV owners.

#### 3.3 Charging Process

The process begins with the vehicle being parked over the charging pad, where the wireless power transfer occurs. Solar panels collect energy, which is then either stored in batteries or directly transmitted to the charging pad. The energy is transferred to the EV's battery through the inductive charging system, ensuring efficient and wireless energy flow.

### 4. METHODOLOGY

#### Step 1: Component Selection

- ATmega328 Microcontroller
- IRFZ44 MOSFETs
- BC547 Transistors
- 4017 Decade Counter IC
- Bridge Rectifiers
- Inductive Coils (Transmitter & Receiver)
- Solar Panel (12V output)
- Step-down Transformer (230V to 12V AC)
- 7805 Voltage Regulator
- LCD 16x2 Display

#### Step 2: Power Source Integration

- AC power is stepped down and rectified to ~15.6V DC.
- Solar power is regulated via batteries and a DC supply path.
- A switch (SW1) selects the active power source.



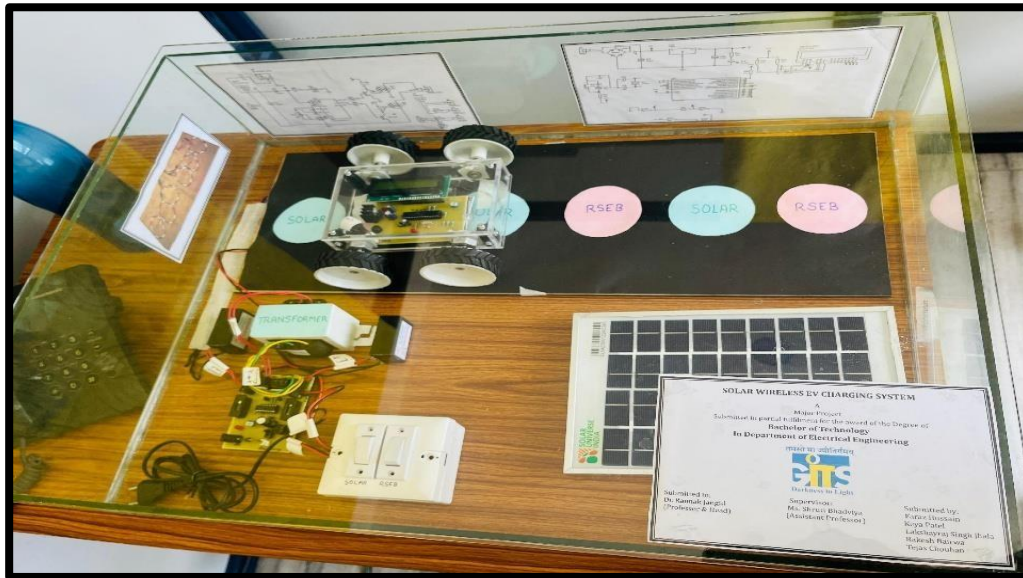


Fig. 5.3: Final Look of the Complete Project

## 6. CALCULATIONS

**Power Requirement-**  $P = V * I = 12V * 1A = 12W$

**Rectified Output Voltage-**  $V_{peak} = 12V * 1.414 = 16.97V$   $V_{filtered} = V_{peak} - 1.4V = 15.6V$

**Regulator Drop-**  $P_{loss} = (15.6V - 5V) * 0.5A = 5.3W$

**Charging Time for Battery**  $T = 1.2Ah / 1A = 1.2$  hours

**Charging Current**  $I = 1A$

**Wireless Efficiency Estimate** Assumed wireless transmission efficiency = 50% Output Power =  $12W * 0.5 = 6W$

## 7. ADVANTAGES OF SOLAR WIRELESS EV CHARGING

### 7.1 Environmental Benefits

By relying on solar energy, solar wireless EV charging systems reduce greenhouse gas emissions, as solar energy is a clean, renewable source. Unlike conventional EV charging that depends on fossil fuel-based power grids, solar-powered systems reduce the carbon footprint of EVs significantly. Additionally, the integration of wireless technology eliminates the need for physical connectors, reducing wear and tear and contributing to fewer maintenance needs, which ultimately reduces waste generation.

### 7.2 Convenience and Accessibility

Wireless charging offers greater convenience for EV owners, as it eliminates the need for plugging in cables. The simplicity of just parking over a charging pad makes it an attractive option for public charging stations, office spaces, and home charging units. With solar panels incorporated into the infrastructure, charging stations can be set up in remote or off-grid locations, improving accessibility to charging facilities.

### 7.3 Cost Efficiency

Over time, the installation of solar-powered charging infrastructure becomes a cost-effective solution. While the initial setup may require a significant investment in solar panels and wireless charging technology, the long-term operational costs are minimal. Solar energy is free, and once the system is installed, maintenance costs are lower compared to traditional grid-powered stations, which may involve ongoing electricity costs.

## 8. CHALLENGES AND LIMITATIONS

While the potential of solar wireless EV charging systems is significant, there are several challenges and limitations that must be addressed.

### 8.1 Efficiency Losses

One of the major challenges in wireless charging systems is efficiency. The energy loss during the wireless power transfer process, primarily due to distance, misalignment, and interference, can reduce the overall efficiency of the charging process. Current wireless charging systems for EVs have an efficiency of approximately 80-90%, which is lower than traditional wired systems, which can achieve 95% efficiency or more.

### 8.2 Solar Energy Variability

Solar energy generation is highly dependent on environmental conditions such as weather, time of day, and geographic location. In regions with limited sunlight, solar-powered EV charging may not provide sufficient energy to meet the demand. The intermittency of solar power means that energy storage solutions (such as batteries) are necessary to ensure that vehicles can be charged at all times, adding to the overall complexity of the system.

### 8.3 Infrastructure and Space Requirements

The installation of solar panels and wireless charging pads requires significant space. For widespread deployment, large areas like parking lots, rooftops, or highways need to be equipped with these systems. In urban areas, where space is limited, this can be a challenge. Furthermore, the cost and space required for installing wireless power transfer infrastructure and solar panels may pose barriers to large-scale adoption.

### 8.4 Regulatory and Safety Concerns

Wireless power transfer systems, especially those operating at high frequencies, may raise concerns about safety and electromagnetic interference. Regulatory standards for electromagnetic emissions need to be strictly followed to avoid potential health risks. Furthermore, ensuring compatibility between different EV models and the wireless charging system is crucial to prevent safety hazards.

## 9. TECHNOLOGICAL ADVANCEMENTS AND RESEARCH DIRECTIONS

To overcome the challenges associated with solar wireless EV charging systems, ongoing research is exploring innovative solutions in several key areas.

### 9.1 Enhancing Efficiency

Researchers are working to improve the efficiency of wireless power transfer systems through better coil design, materials, and optimization of energy transfer protocols. Techniques such as resonance coupling and multi-coil systems are being studied to reduce losses and improve the overall charging speed.

### 9.2 Energy Storage Solutions

Advanced energy storage systems, such as high-capacity batteries and super capacitors, are being developed to store excess solar energy generated during the day for use at night or during cloudy periods. These storage systems can provide a steady supply of power to wireless charging stations and EVs, reducing the reliance on grid power and enhancing the overall reliability of solar wireless EV charging systems.

### 9.3 Smart Grid Integration

Integrating solar wireless EV charging systems with smart grids can optimize energy usage. By using real-time data, smart grids can efficiently manage the distribution of solar energy and prioritize charging based on the availability of solar power. Additionally, smart charging solutions can allow EVs to be used as mobile energy storage units, feeding power back into the grid during peak demand times.

### 9.4 Development of Standardized Protocols

To address issues of compatibility, the development of universal standards for wireless EV charging systems is crucial. Standardized protocols will ensure that vehicles from different manufacturers can charge seamlessly across various systems, enhancing the scalability of wireless EV charging infrastructure.

## CONCLUSION

Solar wireless EV charging systems represent a significant advancement in the quest for sustainable and efficient energy solutions for electric vehicles. By combining the renewable power of solar energy with the convenience of wireless charging, these systems offer a promising alternative to conventional charging methods. However, challenges such as efficiency losses, space requirements, and energy storage need to be addressed for widespread adoption. Ongoing research and technological advancements are paving the way for more efficient, cost-effective, and scalable solar wireless charging solutions. As these systems become more refined, they have the potential to play a pivotal role in the future of electric mobility, helping to reduce carbon emissions and create a more sustainable transportation infrastructure.

## REFERENCES

- [1] M. A. Hannan, M. M. Hoque, A. Mohamed, A. Ayob, "Review of Energy Storage Systems for Electric Vehicle Applications: Issues and Challenges", *Renewable and Sustainable Energy Reviews*, 2017.
- [2] S. Y. Hui, W. Zhong, C. K. Lee, "A Critical Review of Recent Progress in Mid-Range Wireless Power Transfer", *IEEE Transactions on Power Electronics*, 2014.
- [3] K. K. Afridi, "Wireless Power Transfer for Electric Vehicles: Overview and Challenges", *IEEE Journal of Emerging and Selected Topics in Power Electronics*, 2013.

- [4] M. Yilmaz, P. T. Krein, "Review of Battery Charger Topologies, Charging Power Levels, and Infrastructure for Plug-In Electric and Hybrid Vehicles", IEEE Transactions on Power Electronics, 2013.
- [5] Vyas, M., Vardia, M., Kumar, V., Vyas, S., Joshi, Y. (2022). Power Quality Improvement by Using STATCOM for DFIG-Based Wind Energy Conversion System. In: Bansal, R.C., Zemmari, A., Sharma, K.G., Gajrani, J. (eds) Proceedings of International Conference on Computational Intelligence and Emerging Power System. Algorithms for Intelligent Systems. Springer, Singapore. [https://doi.org/10.1007/978-981-16-4103-9\\_22](https://doi.org/10.1007/978-981-16-4103-9_22)
- [6] Shripati Vyas, Raunak Jangid, Rajat Janwa, Kunal Prajapat, Vishal Singh Dahiya. BLUETOOTH CONTROL HOME AUTOMATION. 2024. International Journal of Technical Research & Science. <https://doi.org/10.30780/specialissue-ISET-2024/048>. Page 284-290
- [7] Jain, C., Jangid, R., Sisodiya, M., Garg, V. "ANN-Based DVR for Fault Mitigation and Performance Optimization in Hybrid PV-Wind Energy Conversion Systems", International Journal of Technical Research & Science. Volume X, Issue VI, June 2025. DOI Number: <https://doi.org/10.30780/IJTRS.V10.I06.007>
- [8] Sisodiya, M., Jangid, R., Jain, C., Garg, V. "Short-Term Load Forecasting (STLF) Using Machine Learning Models: A Comparison Based Study to Predict the Electrical Load Requirements", International Journal of Technical Research & Science. Volume X, Issue VI, June 2025. DOI Number: <https://doi.org/10.30780/IJTRS.V10.I06.007>
- [9] Verma, C., Jangid, R. "Smart Household Demand Response Scheduling with Renewable Energy Resources", IEEE Third International Conference on Intelligent Computing and Control System (ICICCS-2019), Organized by Vaigai College of Engineering during May 15-17, 2019 at Madurai, India. (Scopus index) DOI: 10.1109/ICCS45141.2019.9065908.
- [10] Y. Joshi, J. K. Maherchandani, V. K. Yadav, R. Jangid, S. Vyas and S. S. Sharma, "Performance Improvement of Standalone Battery Integrated Hybrid System," 2021 7th International Conference on Electrical Energy Systems (ICEES), Chennai, India, 2021, pp. 250-255, doi: 10.1109/ICEES51510.2021.9383636
- [11] Aarif, M., Joshi, D., Jangid, R. "Grid Power Smoothing Management for Direct Drive PMSG Variable Speed Wind Energy Conversion System with Multilevel Converter", IEEE 7th International Conference on ICT for Sustainable Development (ICT4SD 2022), Organized by Global Knowledge Foundation during 29-30, July 2022 at Goa, India. (Springer Scopus index) [https://doi.org/10.1007/978-981-19-5331-6\\_3](https://doi.org/10.1007/978-981-19-5331-6_3)
- [12] K. Kusakana, "Feasibility Analysis of Renewable Energy Powered Electric Vehicle Charging Stations", Energy Reports, 2015.
- [13] SAE International, "SAE TIR J2954 Wireless Power Transfer for Light-Duty Plug-In/Electric Vehicles and Alignment Methodology", SAE Technical Standard, 2017.