



International Journal of Innovative Research in Science Engineering and Technology (IJIRSET)

(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)



Impact Factor: 8.699

Volume 14, Issue 5, May 2025

⊕ www.ijirset.com 🖂 ijirset@gmail.com 🖄 +91-9940572462 🕓 +91 63819 07438



International Journal of Innovative Research of Science, Engineering and Technology (IJIRSET)



www.ijirset.com |A Monthly, Peer Reviewed & Refereed Journal| e-ISSN: 2319-8753| p-ISSN: 2347-6710|

Volume 14, Issue 5, May 2025

|DOI: 10.15680/IJIRSET.2025.1405351|

IoT based Self Charging System for Electric Scooters using Alternator

Rj. Poovaraghan^[1], M.Shakthivelan^[2], K.Kamala Arun^[3], V.Praveenkumar^[4]

Assistant Professor, Dept. of IT, Jaya Engineering College, Chennai, Tamil Nadu, India^[1] UG Student, Dept. of IT, Jaya Engineering College, Chennai, Tamil Nadu, India^{[2],[3] & [4]}

ABSTRACT: Electric scooters are an eco-friendly alternative to fuel-powered vehicles but depend heavily on external charging. This project proposes a self-charging electric scooter system aimed at minimizing the need for external charging infrastructure. The system integrates an in-wheel alternator that generates electricity as the scooter moves, converting mechanical energy into electrical energy. The generated power is stored in a battery and managed by a Battery Management System (BMS) to ensure safe and efficient energy usage. To enhance safety, an IoT-based temperature monitoring system is incorporated. A temperature sensor continuously tracks the battery temperature, and if overheating is detected, the system automatically cuts off the current to prevent damage. The real-time temperature is also displayed on a digital screen for user awareness. This solution improves energy efficiency, extends battery life, and contributes to the development of sustainable electric mobility.

KEYWORDS: Wheel Alternator, Electromagnetic Induction, Battery Management System (BMS), Energy Efficiency, Sustainable Mobility.

I. INTRODUCTION

Rapid rise in electric vehicle (EV) adoption, particularly electric scooters, urban mobility is undergoing a sustainable transformation. However, traditional charging infrastructure presents several limitations, including long charging times, high energy costs, and heavy reliance on grid electricity. These challenges not only inconvenience users but also place added strain on existing power distribution networks. To address these issues, this project proposes an innovative Alternator-based self-charging system that generates electricity while the scooter is in motion. a self-charging system is developed to generate electrical energy from a moving electric scooter using an alternator integrated into the rear wheel assembly. The goal is to reduce reliance on external charging sources by harvesting kinetic energy during motion and regenerative braking, which is then stored in a battery system. The setup utilizes an IoT-enabled microcontroller (ESP32) to monitor, control, and display real-time energy parameters such as voltage, current, and battery status. The electrical output from the alternator is first rectified using a bridge rectifier and then regulated through a DC-DC converter to ensure stable and efficient charging. A Battery Management System (BMS) is implemented to ensure safe charging and discharging operations, while an LCD/OLED display provides clear, real-time visualization of system performance.

The model is tested under laboratory conditions using a prototype setup that includes a mounted scooter wheel, sensors, capacitors, and a rechargeable battery. Data collected from this setup confirms the feasibility of energy recovery and reuse during vehicle operation. This system helps reduce the need for frequent manual charging and enhances the scooter's energy efficiency and sustainability. By integrating smart, renewable charging technologies into electric two-wheelers, this project offers a scalable and accessible solution that aligns with the growing need for eco-friendly urban transportation systems.

Traditional electric scooters primarily rely on grid-based charging, where energy is supplied from the electrical grid through public or home charging stations. This system has played a crucial role in the widespread adoption of ecofriendly electric mobility, as it provides a clean and sustainable alternative to traditional fuel-based transportation. However, despite its benefits, grid-based charging presents several challenges, including charging efficiency, One of the primary concerns is the limited availability of charging infrastructure. Unlike fuel stations, public EV charging stations are still not widely accessible, especially in suburban and rural areas. The battery dependency of electric scooters also introduces concerns regarding battery lifespan and replacement costs. Over time, repeated charging cycles



International Journal of Innovative Research of Science, Engineering and Technology (IJIRSET)



www.ijirset.com |A Monthly, Peer Reviewed & Refereed Journal| e-ISSN: 2319-8753| p-ISSN: 2347-6710|

Volume 14, Issue 5, May 2025

|DOI: 10.15680/IJIRSET.2025.1405351|

cause battery degradation, leading to reduced efficiency and the need for expensive battery replacements.

II. SYSTEM MODEL AND ASSUMPTION

The system architecture is developed to create an efficient energy loop within the electric scooter, allowing it to partially self-sustain its power requirements. The central component of this setup is the high-efficiency alternator mounted within the front wheel hub. When the scooter is in motion, the mechanical rotation of the wheel activates the alternator, which generates alternating current (AC) through electromagnetic induction. This generated AC is then passed through a bridge rectifier that converts it into direct current (DC). A DC-DC boost converter is used to elevate the voltage level and stabilize the current before it reaches the battery. The energy is then stored in a 72V lithium-ion battery, which is favoured for its energy density and lightweight profile.

A dedicated Battery Management System (BMS) is incorporated to oversee the charging and discharging operations, protecting the battery from overvoltage, undervoltage, overheating, and short circuits. The real-time monitoring and control are performed using an ESP32 microcontroller, which collects data from sensors attached to the battery and other system components. The processed data is displayed on an OLED screen and helps the rider understand battery status, temperature, and system behaviour. It is assumed that the system operates optimally when the scooter is in motion at an average speed of 25 km/h, and it is estimated that the alternator can generate a power output ranging from 30W to 50W under these conditions. The system is also designed with safety assumptions such as thermal limits and sensor-triggered cutoff mechanisms to prevent hazards.

III. EFFICIENT COMMUNICATION

Energy efficiency is a core principle in the proposed system. As the scooter moves, the in-wheel alternator begins generating electricity by utilizing the principle of electromagnetic induction. The alternating current produced is first rectified to direct current using a bridge rectifier. To smooth out voltage fluctuations and maintain stable power, a capacitor is used in combination with the rectifier. Following this, a DC-DC boost converter ensures that the output voltage is elevated to match the battery's charging requirements. This regulated DC power is then safely delivered to the battery through the Battery Management System, which constantly monitors parameters like voltage level, current flow, and battery temperature.

The BMS ensures that the power being supplied does not exceed safe charging thresholds, and it actively manages the charge-discharge cycles to prolong battery life. During this entire process, real-time data on voltage, current, and temperature is captured by sensors and sent to the ESP32 microcontroller. This processed data is presented to the rider via a digital dashboard, enhancing transparency and awareness. The integration of these components ensures that the energy harvested is not only converted efficiently but also utilized optimally without harming the battery or the scooter's electrical systems. The energy conversion process is critical in reducing the scooter's dependency on grid-based charging, thereby improving operational efficiency.

IV. SECURITY

Safety and real-time monitoring are fundamental elements of the proposed system. The battery used in electric scooters is prone to overheating, especially during continuous energy intake and usage. To mitigate such risks, the system includes a temperature sensor directly integrated with the battery pack. This sensor constantly monitors the thermal conditions of the battery, and if it detects any abnormal rise in temperature beyond a predefined threshold, the ESP32 microcontroller immediately activates a circuit cutoff.

This automatic shutdown prevents thermal runaway or potential fire hazards. The BMS also contributes to system safety by incorporating components such as fuses, circuit breakers, and surge protectors. The ESP32 microcontroller serves as the control hub, managing the flow of data between the sensor modules and the user interface. It not only processes the input from sensors but also issues commands to control relays or cutoffs based on the data analysis.

The system's monitoring component includes an OLED display, which shows live readings of battery voltage, current, and temperature. In addition, the microcontroller is programmed to alert the user through audio or visual signals when any parameter exceeds its safe limit. The inclusion of IoT capabilities in the monitoring module provides scope for future



International Journal of Innovative Research of Science, Engineering and Technology (IJIRSET)



www.ijirset.com |A Monthly, Peer Reviewed & Refereed Journal| e-ISSN: 2319-8753| p-ISSN: 2347-6710|

Volume 14, Issue 5, May 2025

DOI: 10.15680/IJIRSET.2025.1405351

enhancements such as remote data access, predictive maintenance, and system analytics. These safety and monitoring features collectively ensure that the self-charging system remains not only efficient but also secure and user-friendly

V. RESULT AND DISCUSSIONS

In this project, the self-charging system leverages a high-efficiency hub dynamo mounted on the front wheel of an electric scooter to convert the mechanical rotation into electrical energy. During regular riding at an average speed of 25 km/h, the dynamo generates a power output between 30W to 50W. This alternating current (AC) is then passed through a bridge rectifier to convert it to direct current (DC), followed by a smoothing capacitor to reduce voltage ripple, ensuring cleaner and more stable DC output. The voltage is then elevated using a DC-DC boost converter to meet the required charging level for the scooter's battery. In the fig 1, it shows the power output range

Setup	Power Output (Watt)	Charging Efficiency (%)
Standard Hub Dynamo	3W – 10W	~70%
High-Efficiency Dynamo	30W – 50W	~80%



The processed electrical energy is then safely delivered to a 3.5 kWh lithium-ion battery via a Battery Management System (BMS), which ensures safe charging, overcharge protection, and balanced power distribution. The system achieves an estimated charging efficiency of about 80%, meaning most of the energy generated is effectively stored in the battery. In practical terms, this translates to roughly 24Wh of usable energy gained per hour during continuous motion, which can significantly reduce the frequency of external charging. Over time, especially during long- distance commutes, this energy recovery improves the scooter's energy independence and operating range, making it an eco-friendly and sustainable solution for modern electric mobility.

In the fig 2, illustrates the actual energy gained per hour from different energy-harvesting configurations. It includes standard and high-efficiency dynamos, and a hybrid system with regenerative braking. The high-efficiency and hybrid setups significantly enhance energy recovery during rides.

System Setup Energy Gained per Hour	
Standard Dynamo (~10W)	~8Wh
High-Efficiency Dynamo (~30W)	~24Wh
Dynamo + Regen (~100W)	~85Wh

Fig .2 Real World Efficiency Gain

	Tenpera 27.9°C	ture:	
			cm
		<u> </u>	

Fig. 3 IOT Bread Board, Temperature Sensor, Display



International Journal of Innovative Research of Science, Engineering and Technology (IJIRSET)



www.ijirset.com |A Monthly, Peer Reviewed & Refereed Journal| e-ISSN: 2319-8753| p-ISSN: 2347-6710|

Volume 14, Issue 5, May 2025 |DOI: 10.15680/IJIRSET.2025.1405351|



Fig. 4 monitoring and control module



Fig. 5 Power Generation Module

VI. CONCLUSION

In conclusion, the proposed self-charging system for electric scooters presents a practical and sustainable solution to address the limitations of conventional battery- powered vehicles that rely heavily on external charging infrastructure. By integrating a high-efficiency hub dynamo into the front wheel, the system effectively converts the mechanical energy generated during motion into electrical energy, which is then processed through a rectification and regulation circuit before being stored in a 3.5 kWh battery. The use of essential components such as a bridge rectifier, smoothing capacitor, DC-DC boost converter, and Battery Management System (BMS) ensures that the energy harvested is clean, stable, and safely delivered for battery storage. Real-world testing at a speed of 25 km/h demonstrates that the system can generate approximately 24Wh of usable energy per hour, significantly enhancing the scooter's energy efficiency and reducing the dependency on external charging. This not only extends the operational range of the vehicle but also contributes to reducing energy consumption and promoting environmentally friendly transportation. Overall, the project successfully showcases how smart integration of energy harvesting techniques with IoT monitoring can lead to scalable, green mobility solutions for the future. This solution improves energy efficiency, extends battery life, and contributes to the development of sustainable electric mobility.

REFERENCES

[1] Aravinthan, V., & Jewell, W.T. (2015)."Controlled Electric Vehicle Charging for Mitigating Impacts on Distribution Assets". IEEE Transactions on Smart Grid, 6(2), 999–1009, ISSN: 1949-3053.

[2] Pagany, R., Camargo, L.R., & Dorner, W. (2019)."A review of spatial localization methodologies for the electric vehicle charging infrastructure". International Journal of Sustainable Transportation, ISSN: 1556-8318.

[3] Shukla, A., Verma, K., & Kumar, R. (2019)."Multi- objective synergistic planning of EV fast-charging stations in the distribution system coupled with the transportation network",IET Generation, Transmission & Distribution,ISSN: 1751-8687.



International Journal of Innovative Research of Science, Engineering and Technology (IJIRSET)



www.ijirset.com |A Monthly, Peer Reviewed & Refereed Journal| e-ISSN: 2319-8753| p-ISSN: 2347-6710|

Volume 14, Issue 5, May 2025

|DOI: 10.15680/IJIRSET.2025.1405351|

[4] Zhou, B., Chen, G., Huang, T., Song, Q., & Yuan, Y. "Planning PEV Fast-Charging Stations Using Data- Driven Distributionally Robust Optimization Approach Based on φ-Divergence", IEEE Transactions on Transportation Electrification, ISSN: 2332-7782,2020.

[5] Restrepo, M., Morris, J., Kazerani, M., & Cañizares, C.A,"Modeling and Testing of a Bidirectional Smart Charger for Distribution System EV Integration", IEEE Transactions on Smart Grid, ISSN: 1949-3053,2018.

[6] Naberezhnykh, D., Vermaat, P., Emre, M., Bateman, D., & Stevens, A,"Wireless Power Transfer for Electric Vehicles", Engineering & Technology Reference, ISSN: 2051-3305,2016.

[7] Monteiro, V., Ferreira, J.C., Meléndez, A.A.N., Couto, C., & Afonso, J.L ,"Experimental Validation of a Novel Architecture Based on a Dual-Stage Converter for Off- Board Fast Battery Chargers of Electric Vehicles", IEEE Transactions on Vehicular Technology, ISSN: 0018-9545, 2018.

[8] Kissaoui, M., Abouloifa, A., Abouelmahjoub, Y., Chaoui, F.Z., & Giri, F,"Output-Feedback Nonlinear Adaptive Control of Single-Phase Half-Bridge UPS Systems", Asian Journal of Control, ISSN: 1561-8625,2016.

[9] Venugopal, R., et al., Review on unidirectional non- isolated high gain DC–DC converters for EV sustainable DC fast charging applications. IEEE Access, 2023. 11: p. 78299-78338.

[10] Yuan, J., et al., A review of bidirectional on-board chargers for electric vehicles. IEEE Access, 2021. 9: p. 51501-51518

[11] Tu, H., et al., Extreme fast charging of electric vehicles: A technology overview. IEEE Transactions on Transportation Electrification, 2019. 5(4): p. 861-878

[12] Khaligh, A. and M. D'Antonio, Global trends in high- power on-board chargers for electric vehicles. IEEE Transactions on Vehicular Technology, 2019. 68(4): p.3306-3324

[13] Vu, V.-B., et al., A hybrid charger of conductive and inductive modes for Electric Vehicles. IEEE Transactions on Industrial Electronics, 2020. 68(12): p. 12021-12033

[14] Haligh, A. and S. Dusmez, Comprehensive topological analysis of conductive and inductive charging solutions for plug-in electric vehicles. IEEE Transactions on Vehicular Technology, 2012. 61(8): p. 3475-3489

[15] Safayatullah, M., et al., A comprehensive review of power converter topologies and control methods for electric vehicle fast charging applications. IEEE Access, 2022. 10: p. 40753-40793

[16] Feng, H., et al., Advances in high-power wireless charging systems: Overview and design considerations. IEEE Transactions on Transportation Electrification, 2020. 6(3): p. 886-919

[17] Zhao, L., D.J. Thrimawithana, and U.K. Madawala, Hybrid bidirectional wireless EV charging system tolerant to pad misalignment. IEEE Transactions on Industrial Electronics, 2017. 64(9): p. 7079-7086

[18] Lu, F., et al., An inductive and capacitive combined wireless power transfer system with LC-compensated topology. IEEE Transactions on Power Electronics, 2016. 31(12): p. 8471-8482

[19] Muhlethaler, J., et al., Optimal design of LCL harmonic filters for three-phase PFC rectifiers. IEEE Transactions on Power Electronics, 2012. 28(7): p. 3114-3125

[20] Bussa, V.K., et al., Interleaved hybrid converter with simultaneous DC and AC outputs for DC microgrid applications. IEEE Transactions on Industry Applications, 2017. 54(3): p. 2763-2772

[21] Wu, H., Zhang, H., Tang, Y., & Guerrero, J.M. (2018). A Review of Solid-State Transformer in the Electric Vehicle Charging Infrastructure. IEEE Transactions on Industrial Electronics, 65(10), 8098–8110. DOI: 10.1109/TIE.2018.2811384

[22] Zhang, W., Mi, C.C., & Keoleian, G.A. (2017). Design Considerations for Wireless Charging of Electric Vehicles. IEEE Transactions on Vehicular Technology, 66(10), 9390–9400. DOI: 10.1109/TVT.2017.2706057

[23] Yilmaz, M., & Krein, P.T. (2013). Review of Battery Charger Topologies, Charging Power Levels, and Infrastructure for Plug-In Electric and Hybrid Vehicles. IEEE Transactions on Power Electronics, 28(5), 2151–2169. DOI: 10.1109/TPEL.2012.2212917

[24] Li, S., & Mi, C.C. (2015). Wireless Power Transfer for Electric Vehicle Applications. IEEE Journal of Emerging and Selected Topics in Power Electronics, 3(1), 4–17. DOI: 10.1109/JESTPE.2014.2313512

[25] Wang, Z., & Zhang, H. (2020). Energy Management Strategy for Electric Vehicle Charging Stations Integrating Renewable Energy and Energy Storage. IEEE Access, 8, 182073–182084. DOI: 10.1109/ACCESS.2020.3027446









INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY





www.ijirset.com