IJARSCT
ISSN: 2581-9429
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
Volume 5, Issue 1, May 2025
Impact Factor: 7.67

# Wireless Electric Vehicle Charging using IoT for Smart Cities

**Mrs. B. Meenakshi[1], Miyapuram Likhitha[2], Sarimalla Manaswi[3]**
[1]Assistant Professor, Mahatma Gandhi Institute of Technology, Hyderabad, India
[2,3]UG Student, Mahatma Gandhi Institute of Technology, Hyderabad, India

**Abstract:** *Electric vehicles are a new and future technology in the transportation and power sector that has numerous benefits in terms of profitable and environmental. This system presents an IoT-based wireless charging system for electric vehicles, designed to enhance the user experience by enabling autonomous, efficient, and real-time management of charging processes. The car will receive the charge wirelessly through inductive coupling, which transfers power to a receiver coil mounted underneath the vehicle to connect to the battery. Devices like the Arduino UNO, relays, and ultrasonic distance sensors are used for IoT-based charging to portray the future of how an EV can be charged independently. For multiple EVs charging simultaneously, it gets burdensome to manage with the traditional wiring. This system integrates IoT into wireless charging stations to provide real-time monitoring, enabling operators to remotely manage and optimize charging sessions. The setup also automates vehicle alignment for charging, enhances the overall user experience, and supports the development of a smarter, more sustainable charging infrastructure*.

**Keywords:** Electric Vehicles (EVs), Wireless Charging, Internet of Things (IoT), Inductive Coupling, Autonomous Charging, Real-time Monitoring, Smart Charging Infrastructure, Arduino UNO, Ultrasonic Sensors, Relay Modules, Battery Management, Sustainable Energy, Charging Optimization, Automated Vehicle Alignment

## I. INTRODUCTION

Electric Vehicles prove to be a step of revolution for attaining sustainable transport, as their emissions toward greenhouse gases are definitely minimal compared to their counterparts, which are the internal combustion engine vehicles. The efficiency of electric vehicles in the war against climate change and curbing down the harmful impacts of the transport sector is unparallel, whereas the current EV charging infrastructure has some spectacular flaws.

Most rely on plug-in charging, which is cumbersome and time-consuming. Drivers have to physically connect their vehicles to charging stations, which is not only cumbersome but also causes wear and tear, making the charging infrastructure less durable with time. This has made EV charging less efficient and accessible, limiting its wide adoption.

In the context of smart cities, where efficiency, automation, and sustainability are the cornerstones of development, there is an increasing need for innovative solutions to streamline everyday operations. The vision of a smart city emphasizes the seamless integration of technology into urban infrastructure to optimize resource usage and enhance the quality of life for residents. EV charging infrastructure is a critical component of this vision, but traditional plug-in systems mostly fail to keep up with modern urban environments. Autonomous, user-friendly, and aligned to the principles of smart city development, smart wireless EV charging systems are what is needed now. Wireless EV charging system is a radical approach to those limitations. Eliminating the need for physical cables and connectors, using WPT technology such as inductive or resonant magnetic coupling in these systems innovation not only makes the charging process easier but also reduces the possibility of damage to the infrastructure and also reduces maintenance needs. Wireless charging systems are by their nature more consumer-friendly as cars can be charged without effort whenever they are parked over designated charging pads.

IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429
Volume 5, Issue 1, May 2025
Impact Factor: 7.67

IoT is integrated with the wireless EV charging systems. IoT provides for high-end features like real-time monitoring, remote control and predictive maintenance. Sensors as well as devices placed in the infrastructure of charging can collect and analyze data regarding energy usage, charging patterns by vehicles, and overall systems performance. This has enabled the efficient distribution of energy, the elimination of unnecessary waste, and efficient functioning. Furthermore, Iot-based wireless charging systems can easily integrate with smart grids, rendering it possible to use renewable energy sources and contribute to the overall sustainability of an urban environment. Combining wireless power transfer with the capability of the IoT, the solution will serve not only for more convenient and efficient EV charging but also assist the greater agenda of sustainable development in cities. This aligns with the visions of smart cities in cleaner alternatives to transportation while decreasing reliance on fossil fuels as well as improved quality of life.

***A. Problem Statement.***

The EVs have advantages related to environmental concerns, but growth is restrained due to ineffective charging infrastructure. The disadvantage of manual plug-in charging is that it may be inconvenient and prone to human error, along with complicated wiring, which may increase costs and maintenance. Due to space limitations in urban environments, it would be difficult to expand traditional charging solutions. Since the system cannot autonomously identify and charge a vehicle or even monitor in real time, automation prevents usability. Public charging stations face congestion, especially during peak hours, which makes waiting time rather long. Additionally, inefficient energy management wastes resource and puts strain on the grid. To overcome these issues, the integration of wireless charging with IoT can help improve efficiency, scalability, and sustainability, thereby paving the way for a more advanced EV infrastructure.

***B. Existing System***

The most common type of EV charging systems is wired and is often used in conjunction with mobile apps, which are more convenient. They have several significant drawbacks: wired EV charging systems require manual operation, making it time-consuming to charge and very prone to human error, especially in bad weather or for physically challenged people. Maintenance is also a challenge; cables and connectors wear out, requiring frequent repairs and high operational costs. Outdoor stations are particularly vulnerable to weather damage, reducing reliability. Additionally, many wired systems lack real-time monitoring, making it difficult for users to track energy consumption or battery health. Operators also struggle with predictive maintenance and efficient energy management due to limited data availability.

## II. PROPOSED SYSTEM

***A. Architecture of Proposed System.***

The proposed IoT based Wireless Electric Vehicle (EV) Charging System has been designed to implement wireless power transfer technique with the integration of IoT technologies. This system is intended to provide a hassle free, time saving and environment friendly charging facility for the drivers who do not want to spend time in connecting their vehicles for charging. Employing inductive coupling principle, power is sent from a transmitter coil fixed at parking slots to a receiver coil attached below the vehicle. Combined with the IoT sub-system which consists of Arduino UNO, ultrasonic sensors and relays, it brings the robotic control and the charge status feedback, and also enhances the charging efficiency.

***B. Advantages of Proposed System.***

- Convenience and Automation
- Sustainability and Environmental Benefits
- Enhanced Safety
- Operational Efficiency

IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429 Volume 5, Issue 1, May 2025 Impact Factor: 7.67

- Improved Scalability
- Enhanced User Experience

## III. LITERATURE SURVEY

A renewable energy system designed especially for smart houses focusing on managing issues related to efficiency, sustainability, and reduction of costs involved in energy development and consumption. Such an innovation merges solar PV, lithium-ion battery, and the intelligent energy management system that has created this fully optimized and framework-based mode for power production, storage, and consumption within its network and offers the reduction in the involvement with traditional electric power grids for utilizing energy supply. By integrating renewable energy sources with intelligent energy management, the proposed system achieves multiple objectives: reducing household energy costs, promoting environmental sustainability, and decreasing reliance on non-renewable grid power. Moreover, this system exemplifies how advanced technology can transform conventional homes into smart homes capable of contributing to a greener and more sustainable future.[1]

Innovative Solution In the sphere of electric vehicles (EVs), one critical challenge is access to charging infrastructure, especially in remote or off-grid areas. This work proposes an adaptive control method for a portable solar-powered EV charging adapter for sustainable and efficient charging of EVs with zero dependence on traditional charging stations. This development is particularly relevant for regions with limited access to electrical grids or charging infrastructure, where EV adoption might otherwise be hindered. The system is designed to be portable, enabling it to be deployed in remote locations or carried by EV users for on-the-go charging. This portability makes it more practical and adaptable to various situations, thus making it a feasible option for emergencies or daily charging in places with no infrastructure. [2]

A novel hybrid energy system intended to improve the performance and sustainability of electric vehicles (EVs). Their research is focused on the utilization of renewable energy sources directly as the vehicle frame, reducing reliance on outside charging systems and increasing cleaner energy use. The new system makes use of solar and wind power to supply a constant and sustainable source of electricity for EVs. The system to be employed combines photovoltaic (PV) solar panels and wind turbines, allowing the vehicle to generate electricity from two renewable sources. The PV panels capture solar energy, converting sunlight into electrical power to charge the EV battery. Simultaneously, wind turbines harness airflow around the moving vehicle, generating additional power when the vehicle is in motion. With the combination of these two renewable sources, the system maximizes energy generation and enhances vehicle efficiency. One of the best advantages of this dual-energy system is that it is capable of delivering power even when the vehicle is parked. Unlike traditional EVs, which are purely dependent on charging points, this hybrid system can produce energy uninterruptedly. This feature expands the range of driving in EVs, reducing dependence on outside charging and keeping use of possibly fossil fuel-based electricity grids at bay. Thus, the system offers greater energy independence and contributes to a cleaner transport sector. Also, integrating renewable energy with EVs reduces greenhouse gas emissions. The conventional process of generating electricity means the use of fossil fuels, but the independent system promises greener and cleaner electricity. Reducing the carbon footprint of EVs ensures the support of global-wide sustainability aims as well as proposals to curtail global warming. Beyond its green benefits, this hybrid solution is a key technological innovation for the EV market. It presents an opportunity for more energy-efficient car architectures that optimize the use of renewable energy sources. As technology advances, these integrated solutions can become mainstream, shaping the future of electric mobility and the greener transport infrastructure.[3]

An interleaved buck converter for electric vehicle (EV) wireless charging systems. Their work is focused on maximizing the efficiency and reliability of EV charging through optimization of the components of the converter and overall performance under different load conditions. The interleaved buck converter has a vital role in voltage regulation and smooth power transfer in wireless EV charging. For the maximum performance, the researchers paid specific attention to component selection and tuning of key elements such as switches, inductors, capacitors, heat sinks, and cooling fans. All the components were selected meticulously to reduce energy losses, decrease heat generation, and enhance power conversion efficiency. One of the most significant challenges for wireless EV charging is ensuring power stability in spite of varying load demands. The research tackles this challenge by designing the interleaved buck converter in a way that it can adjust dynamically to varying operating conditions. With the use of interleaved switching methods, the converter reduces ripple currents and electromagnetic interference, making the charging process more stable and efficient. Material choice and design also contribute significantly to the effectiveness of the converter. The researchers tested different materials to guarantee durability, thermal stability, and excellent electrical performance. Experimental verification was performed to test the efficiency of the converter under practical conditions, validating its ability to provide stable and reliable power to EVs. This research is a landmark in EV wireless charging technology. Through enhanced power conversion efficiency and thermal management, the interleaved buck converter improves the practicability of wireless charging systems. These developments drive the wider usage of EVs by making the charging process easier, more dependable, and more energy-efficient, ultimately leading towards a greener future for transport. [4]

Optimization method for the planning and operation of photovoltaic (PV) energy systems integrated with battery energy storage systems (BESS) as well as electric vehicle charging stations (EVCS) in urban areas. Their research work addresses the concerns of making these systems efficient as well as economical for use in urban settings, particularly in renewable energy integration. The authors now introduce a novel algorithm called IGOA-a combination of features from BESA and GWO-to optimize PV-BESS-EVCS with sizing and energy management. Based on the efficiency of the newly proposed system, the authors design a MATLAB/Simulink model to generate the performance plot and compare this with existing algorithms in real application scenarios. [5]

An extensive study had been focused on the selection of electric vehicle battery charging stations in Thailand. This is because adoption of electric vehicles continues to be on the increase globally, necessitating the increasing need for an all-rounded well-structured charging infrastructure. In a similar scenario as many countries, Thailand struggles with the quest for finding an ideal location of the EV charging station to make them accessible and efficient in light of the fast-growing user population of EV. It is such complexity that was indicated in determining the best places to locate EV charging stations; the decision would depend on interrelated factors. [6].

## IV. SYSTEM DESIGN AND METHODOLOGY

### *A. Design*

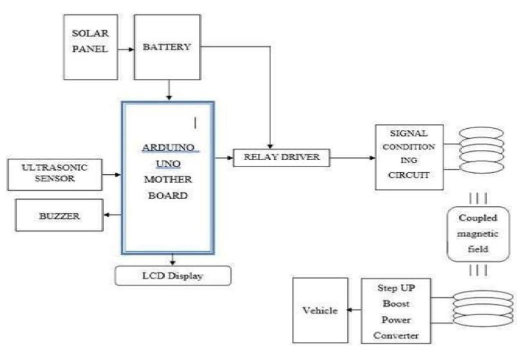



Figure1: System Design

The design portrays how the controlling flow of IoT interacts with significant hardware components. The power source is able to provide a sustainable energy supply that allows for wireless power transfer. There is an emitter coil inside the parking lots, transmitting power wirelessly towards the vehicle while the receiver coil mounted under the EV receives the power transmitted to it for charging purposes. The Arduino UNO plays as a central controller in order to manage sensors and relays in order to automate all functions of the system. It uses 14 ultrasonic sensors to detect presence and proper aligning in the designated charging zone. The relay driver controls the high-power circuits initiating the power transfer when the vehicle is properly aligned. The power received is then converted to the desired voltage for efficient charging of an EV through the use of a step-up boost converter. The energy is finally prepared for transmission through magnetic fields by a signal conditioning circuit to ensure that power is delivered smoothly and reliably to the EV. All these components together create a fully integrated, automated, and efficient wireless EV charging solution.

*B. Methodology:*

The proposed system will be based on a structured methodology, comprising multiple modules to achieve efficient and automated wireless EV charging. Every module has a significant role to play in perfecting seamless operations, from initialization to real-time monitoring.

**Initialization Module**

The Initialization Module initializes the system to ensure proper functioning of all its components: Arduino UNO, ultrasonic sensors, relay modules, and LCD display. It prevents errors and ensures proper configuration, stating this clearly on the display as "System Initialized."

**EV Detection Module**

After activation, the ultrasonic sensors used by the EV Detection Module are able to determine the presence of an electric vehicle in the allocated charging area. These sensors take measurements of the distance and indicate whether a vehicle has entered the charging zone or not. It avoids false activations and starts charging only when the EV is well-positioned in the charging area.

**Alignment Module**

The alignment module ensures that the receiver coil of the EV is well positioned and aligned with the transmitter coil for efficient transfer of power. Ultrasonic sensors constantly monitor the vehicle position and send response signals to the driver or an automated system. In case of misalignment, visual or auditory signs help the driver correct the position of the EV and then continue charging.

**Relay Control Module**

The Relay Control Module oversees the entire power transfer procedure. Upon proper alignment of the EV, the Arduino UNO sends a signal to the relay module, which energizes the charging circuit. The relay stays on throughout the charging period and turns off only if there is some type of charging error, allowing safe and efficient energy transfer.

**Wireless Power Transfer Module**

The Wireless Power Transfer Module allows for contactless energy transfer via Tesla coils, which create a magnetic field around the transmitter coil. This field causes an electrical current in the receiver coil of the EV, thus allowing for efficient charging without any cables. The module monitors and displays the efficiency of the energy transfer in real time.

**Real-Time Monitoring Module**

The Real-Time Monitoring Module enhances user convenience by providing live updates on the charging status, energy consumption, and battery health. An IoT-based dashboard allows remote access, enabling users to track charging progress from their smartphones or computers. Additionally, the system sends alerts in case of misalignment, power failure, or overheating, ensuring reliability and safety.

## V. MODULES

**Initialization Module**

It initializes and gets ready all components in the system during the process of startup. The hardware and software components get confirmed to work well in executing their functions.

**EV Detection Module**

This module determines whether there is an EV or not present at the defined slot of charging in order to activate the process.

**Alignment Module**

The alignment module ensures the receiver coil of the EV is properly aligned with the transmitter coil in the charging station for optimal power transfer.

**Relay Control Module**

This module controls the activation and deactivation of the charging circuit to ensure safe and efficient power transfer.

IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429 Volume 5, Issue 1, May 2025 Impact Factor: 7.67

**Wireless Power Transfer Module**

It permits the transfer of electrical energy without physical connections, from the transmitter coil in the charging station to the receiver coil in the electric vehicle.

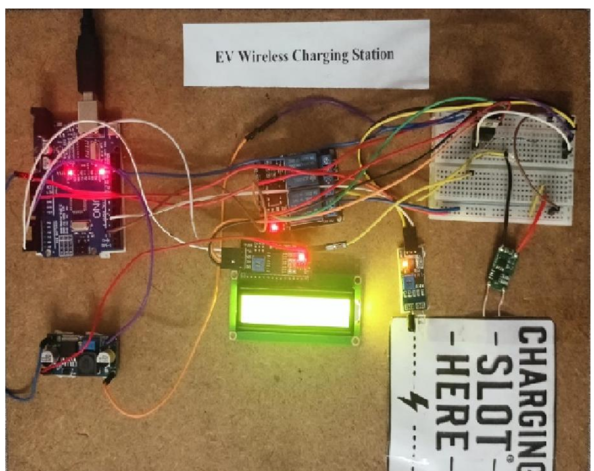
**Real-Time Monitoring Module**

The module will output live updates with respect to the charging process and system performance in order to enhance user convenience and transparency.

## VI. IMPLEMENTATION

The intended wireless electric vehicle charging system employs both hardware and software elements for automatic detection and charging of electric vehicles through IoT technology. Hardware components include an Arduino microcontroller, an infrared sensor for detection of the vehicle, a power flow control relay module, and a Liquid Crystal Display (LCD) for giving feedback to users. When a car enters the charging zone, it is sensed by the IR sensor and a signal is transmitted to the Arduino. Depending on the input condition, the microcontroller gets the data processed and drives the relay to initiate wireless charging with an inductive coil. At the same time, real-time messages appear on the LCD to notify the user of the status of the system, for example, "Slot Free," "Car is Charging," or "Car Disconnected." The control logic is realized through embedded C programming to facilitate efficient coordination between sensor inputs and actuator responses. The system is programmed to shut down automatically when the vehicle leaves or the charging is complete, making it energy-efficient and user-friendly. This deployment proves the viability of integrating smart automation in EV charging stations, increasing ease of use and safety for forthcoming smart cities.

## VII. RESULT




**Startup**


**Welcome Message**

IJARSCT

International Journal of Advanced Research in Science, Communication and Technology

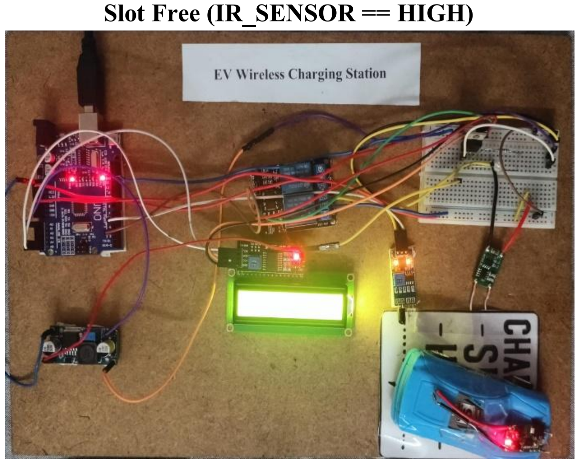
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal

ISSN: 2581-9429

Volume 5, Issue 1, May 2025

Impact Factor: 7.67


Slot Free (IR_SENSOR == HIGH)



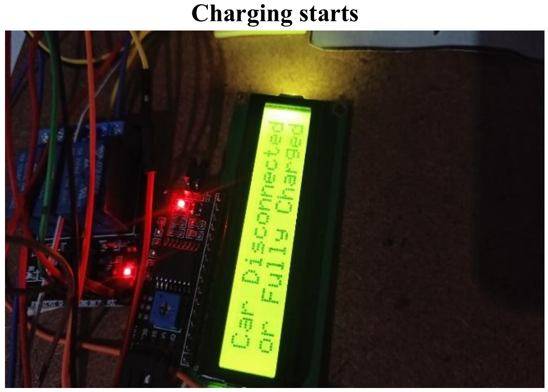

Car on Slot

Processing the detection

IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429
Volume 5, Issue 1, May 2025
Impact Factor: 7.67


**Can’t charge when the vehicle leaves before charging completes**


**Charging starts**




**Charging completed and vehicle leaves**

## VIII. CONCLUSION

Wireless EV charging, integrated with IoT, can be the game-changer that cities are looking for to go greener and smarter. Eliminating the hassle of plugging in means it has charged effortlessly, thereby encouraging more people to switch over to electric vehicles and reduces our dependence on fossil fuels.

With IoT in the mix, such systems become more intelligent. This real-time monitoring helps keep up with the pace of charging progression, battery health, and total system performance. Predictive maintenance catches issues even before they may turn into large problems, so the whole system is reliable in the end. Dynamic power distribution ensures energy consumption is done as efficiently as possible, thus overloading the grid. With smart grids, wireless charging sends cities an optimized path toward energy consumption, synchronization of demand, and harmonious integration of renewable power sources. This is not just an efficiency improvement but also reduces emissions and contributes to better planning. The drivers experience smoother, more convenient charging, while the city planners gain invaluable insights to improve infrastructure.

Long term, it's about using wireless EV charging with IoT to achieve more than powering cars but building cleaner, smarter, and more future-ready cities.

## IX. ACKNOWLEDGEMENT

Genuine appreciation goes to all who have helped make this project on wireless electric vehicle (EV) charging with IoT and embedded technologies successful in its development and completion. Without the dedicated efforts of our project team, encouraging faculty, and cooperation of individuals providing technical as well as practical knowledge along the way, this work would not have been brought to reality.

We especially appreciate our academic mentors and technical advisors, whose counsel on sensor integration, relay control schemes, and embedded system design were instrumental in developing this automated, easy-to-use, and energy-saving charging system. Their guidance enabled us to develop a concept into a functioning prototype with real-time monitoring and intelligent control.We appreciate those who funded the test and simulation phases, which maintained the system's performance invariant despite different operating environments. Their comments gave us the opportunity to make refinement adjustments to responsiveness and safety logic resident in the hardware-software interface.

In closing, we owe a special note of gratitude to the wider family of peers, lab coordinators, and parents who supported us along the way. This work is a witness to the interdisciplinary nature of creativity and the quest to make smarter, more sustainable transportation systems available for the world's future generations.

## REFERENCES

[1] Emodi, N.V.; Akuru, U.B.; Dioha, M.O.; Adoba, P.; Kuhudzai, R.J.; Bamisile, O. The Role of Internet of Things on Electric Vehicle Charging Infrastructure and Consumer Experience. Energies 2023, 16, 4248.

[2] N. Kumar, H. K. Singh and R. Niwareeba, "Adaptive Control Technique for Portable Solar Powered EV Charging Adapter to Operate in Remote Location," in IEEE Open Journal of Circuits and Systems, vol. 4, pp. 115-125, 2023.

[3] Angamarca-Avendaño, D.-A.; Flores-Vázquez, C.; Cobos-Torres, J.-C. A Photovoltaic and Wind-Powered Electric Vehicle with a Charge Equalizer. Energies 2024, 17, 4665.

[4] Kim, JC., Lee, J., Lee, HW. et al. Comparison of Buck-Type DC-DC Converter Design for Electric Vehicle Wireless Charging System Using Railway Power Grid. J. Electr. Eng. Technol. 19, 2787–2801 (2024).

[5] Venkatesh, R., Kalpanadevi, S., Kamali, S.M. et al. Improved gazelle optimization algorithm (IGOA)-based optimal design of solar/battery energy storage/EV charging station. Electr Eng (2024).

[6] Suvittawat, A.; Suvittawat, N. An Integrated Analysis of Electric Battery Charging Station Selection—Thailand Inspired. World Electr. Veh. J. 2024, 15, 418.

[7] M. P. Karthikeyan, M. Mukesh, R. Karthikeyan, T. S. Jaiganesh and R. Dilip, "Smart Electric Vehicle Charging System Using RFID," Chennai, India, 2023, pp.

[8] H. Xiaotao *et al*., "Operation and Maintenance System of Electric Vehicles' Charging and Discharging Facilities Based on Repository," Changsha, China, 2021, pp. 894-897.

[9] P. K. Ray, A. Bharatee, S. Panda and I. N. W. Satiawan, "Modeling and Power Management of Electric Vehicle Charging System," Sanur, Bali, Indonesia, 2021, pp. 100-105.

[10] H. Jung, H. Jang, H. Han, K. Cho, B. Kang and S. Park, "Electric Vehicle Charging System to Reduce Carbon Emissions Using Photovoltaic Power Generationand ESS," Busan, Korea, Republic of, 2022, pp. 1-4.