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Charging System for Electric Vehicles Using Photovoltaic and Wireless Power Transmission Technologies

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Abstract **- The proposed Enhanced Electric Vehicle Charging System represents a groundbreaking innovation in Electric Ve- hicle (EV) charging, seamlessly integrating intelligent processes and wireless technology to revolutionize the charging experience. At its core, this system aims to alleviate range anxiety and the inconvenience of lengthy charging sessions, which have been significant deterrents to the widespread adoption of electric vehicles. By harnessing dynamic wireless charging technology, the system enables vehicles to be charged on the go, eliminating the need for lengthy stops at charging stations, thereby enhancing the driving experience and increasing the overall efficiency of electric vehicle usage. This cutting-edge technology facilitates wireless power transfer while the vehicle is in motion, offering numerous benefits, including convenience, range anxiety mitigation, and infrastructure flexibility. Furthermore, the system's intelligent processes leverage advanced algorithms and data analytics to predict and adapt to the driver's charging needs, optimize energy distribution, and minimize waste, ultimately ensuring a more efficient, sustainable, and user-friendly EV charging experience. As the world continues to embrace electric vehicles as a viable alternative to traditional combustion engine vehicles, solutions like dynamic wireless charging and intelligent process integration will play a pivotal role in shaping the future of mobility, accelerating the transition towards a more sustainable and environmentally friendly transportation future.**

Index Terms **- Photovoltaic Charging, Wireless Power Transmission, Inductive Power Transfer, Electric Vehicles, Renewable Energy, Dynamic Charging, Stationary Wireless Charging, Solar Energy, EV Charging Infrastructure, Power Electronics, Sustainable Transportation, Resonant Coupling,Energy Storage, Clean Mobility**

I. INTRODUCTION

The transportation sector is a significant contributor to global oil consumption and carbon dioxide (CO2) emissions, accounting for over half of the former and a quarter of the latter. This substantial impact on the environment is a critical factor exacerbating the Greenhouse effect, a phenomenon characterized by the Earth's increasing temperature due to the accumulation of greenhouse gases in its atmosphere. The reliance on fossil fuels for transportation not only depletes finite resources but also poses severe environmental challenges, making the transition to more sustainable modes of transportation an imperative.[1][2]

Electric vehicles (EVs) have emerged as a pivotal component in the quest for a sustainable transportation system. By significantly reducing dependency on crude oil and minimizing the emission of pollutants associated with transportation, EVs offer a cleaner, more environmentally friendly alternative. Their growing popularity is a testament to the shifting dynamics in the automotive industry, with an increasing number of consumers and businesses turning to EVs for their transportation needs. From delivery vehicles and corporate fleets to personal trips, the versatility of EVs is expanding, making them an integral part of the future transportation landscape.

However, the widespread adoption of EVs brings forth a considerable challenge: the need for efficient, reliable, and expansive EV recharge infrastructure. As the number of EVs on the road continues to grow, ensuring that these vehicles can be charged conveniently and effectively, without compromising their range or performance, becomes critical. Although significant advancements have been made in enhancing the capacity and driving range of EV batteries, the development of comprehensive charging solutions is equally vital for making EVs a viable option for widespread use.

The evolution of EV batteries has been remarkable, with substantial improvements in both capacity and driving range observed in recent years. These advancements have not only alleviated range anxiety, a common concern among potential EV buyers, but have also made EVs more appealing to a broader audience. However, to fully realize the potential of EVs and integrate them seamlessly into daily life, robust charging infrastructure that supports fast, efficient, and con-

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venient charging is indispensable.

Understanding these industry developments is crucial for EV professionals and stakeholders. By keeping abreast of the latest advancements and trends, they can devise and imple- ment innovative approaches to EV charging and infrastructure development. This proactive approach is essential for overcoming the challenges associated with EV recharge, ultimately facilitating the transition to a more sustainable, carbon-neutral world.

In creating such a world, it is not merely about increasing the adoption of EVs but also about ensuring that the ecosystem supporting them is robust, efficient, and accessible. This includes investing in charging infrastructure, incentivizing the use of renewable energy for charging, and promoting practices that enhance the longevity and performance of EV batteries. Through these concerted efforts, the vision of a sustainable transportation system, powered predominantly by electric vehicles, can become a tangible reality.

The journey towards a carbon-neutral future is complex and multifaceted, requiring the collaboration and commitment of governments, industries, and individuals. Electric vehicles, with their potential to significantly reduce greenhouse gas emissions and dependency on fossil fuels, are a crucial part of this journey. By addressing the challenges associated with their adoption, particularly those related to charging, we can accelerate the transition to sustainable transportation and make meaningful strides towards mitigating climate change. [**?**], [**?**]. The objective of this paper is Unlike static charging, dynamic wireless charging allows EVs to charge on the go, so vehicles do not need to stop to refuel or recharge. Instead, they receive a constant stream of energy across an air gap while the vehicle is in motion. Wires under the road transmit electricity to EVs, using the principle of magnetic induction. [1-3]

II. LITERATURE REVIEW

literature shows strong interest in integrating photovoltaic (PV) energy with wireless power transmission (WPT) technologies to create sustainable, contactless charging systems for electric vehicles (EVs). Studies emphasize that PV-based charging stations reduce grid dependency, operational cost, and carbon emissions, especially when supported by effi- cient Maximum Power Point Tracking (MPPT) techniques. Research highlights the importance of optimizing inductive power transfer (IPT) coil design to enhance wireless charging efficiency and mitigate alignment issues. Hybrid architectures combining PV arrays, battery storage, and WPT systems are widely explored to ensure continuous and stable power flow despite solar fluctuations. Several works also investigate advanced power electronic converters and energy management systems to maximize PV utilization and charging reliability. Dynamic wireless charging, where vehicles receive power while moving, is gaining attention for its potential to extend driving range and reduce battery size requirements. Overall, the literature concludes that integrating PV generation with WPT enhances sustainability, convenience, and long-term EV charging infrastructure resilience.

[1] ”WIRELESS POWER TRANSMISSION FOR ELECTRIC VEHICLE”, Dr.K.Shivarama Krishna, International Journal of Creative Research Thoughts (IJCRT). Integrating features of all the hardware components used have been developed in it. Presence of every module has been reasoned out and placed carefully, thus contributing to the best working of the unit. Secondly, using highly advanced IC’s with the help of growing technology, the project has been successfully implemented. Thus the project has been successfully designed and tested. The offered solution produced less ripple in input/output voltage and current while utilizing a low value of dc link, and filter capacitance values, respectively.

[2]”Coupled Wireless Power Transmission For Electric Automobile”, Mohammed Aleem, International Journal of Creative Research Thoughts (IJCRT). This project presents wireless power charging to an electric vehicle (EV). The concept of wireless power transmission was introduced by nikola tesla. Now-a-days electric vehicles involves in large range of vehicles which includes two Wheeler, three-wheeler and cars. This paper deals with research and development of wireless charging systems for Electric vehicle using wireless power transmission.

[3]”ADVANCED CHARGING SYSTEM FOR AUTOMOBILES”, Dr.V.Raveendra Reddy, International Journal of Creative Research Thoughts (IJCRT). Wireless charging is one of the most convenient charging infrastructures for electric vehicles. It is expensive, but still attracts many researchers. Because electric vehicles can drive for many hours without stopping to charge, they become truly autonomous. Perhaps the most exciting aspect is that electric vehicles equipped with wireless charging technology on the go can have significantly smaller batteries. As a result, this technology reduces both the environmental impact and the cost of introducing electric vehicles.

[4]”STATIC WIRELESS CHARGING STATION FOR ELECTRIC VEHICLES”, Akash Kharpude, International Journal of Creative Research Thoughts (IJCRT). This paper proposes a wireless charging system for electric vehicles (EVs) that aims to address the limitations of traditional plug-in charging systems. The wireless charging system utilizes inductive power transfer technology to transfer energy wirelessly between the charging pad and the EV battery.[4-5]

III. METHODOLOGY

The methodology for the proposed wireless electrical vehicle charging system is centred on utilizing wireless power transfer and integrating a subsequent automated payment and exit system. The process begins with the supply being the input and starting point of the implementation. Once the supply is applied, the transistor starts switching, which, with the help of a copper coil, generates the wireless power. A number of transmitter copper coils are fixed beneath the road base. The receiver copper coil, which is located inside the Electric Vehicle (EV), receives this power without any physical connection. For the power supply section, a step-down transformer is utilized to convert 230V AC to 12V AC. Four rectifier

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 15 Issue 01 , January - 2026

diodes (specifically 1N4007 diodes) are used to form a bridge converter to rectify the AC input, converting it to DC, and a filter capacitor is installed subsequently to smooth the AC output signal. The system relies on hardware components such as the Microcontroller Nodemcu, Transistor (BD139), Cooper Coils, and an Object Sensor (IR Sensor).[5-7] The methodology also details the logistical steps for charging and exiting the system, which are governed by an algorithm run via the IOT module Nodemcu and software like the Arduino IDE. After the vehicle reaches the end of the charging road, the user must pay the accrued charging amount. This amount is visible to the user on an LCD display (16x2). Payment can be made using a smart phone. The algorithm for the system involves enabling the LCD and the IOT module, configuring the module as a server, searching for and auto-connecting with a network, and displaying the IP address. The system then waits for the payment key press. Once the payment is successful, a GPIO signal is generated for the gate motor to open and close, allowing the user to automatically exit from the charging road. The successful implementation of this project has produced less ripple in input/output voltage and current while utilizing a low value of DC link and filter capacitance values.[6][7]

IV. BLOCK DIAGRAM AND WORKING

A. block diagram

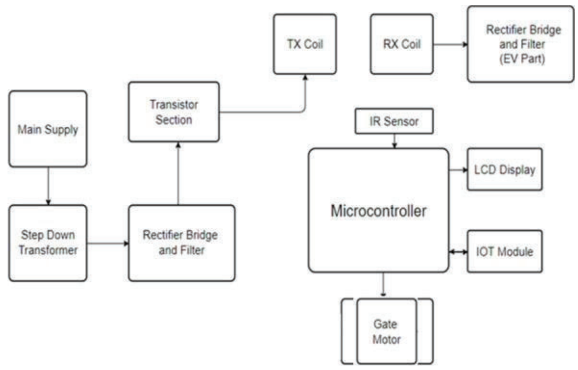

Fig. 1. Block diagram of Charging System for Electric Vehicle using Photovoltaic and Wireless Power Transmission Technologies

B. working

The above fig 1 explain the operation of the wireless electrical vehicle charging system encompasses three primary phases: power preparation, wireless power transfer (WPT), and the automated payment and exit sequence. The overarching design utilizes dynamic wireless charging, a method that allows Electric Vehicles (EVs) to charge while in motion, using the principle of magnetic induction. This ability to charge continuously while operating on roads can significantly increase a vehicle's trip range and reduce the overall requirement for massive, heavy onboard energy storage. The system's working begins with the power supply section, where incoming utility power is processed for transmission. A step-down transformer is necessary to convert the high voltage input (230V AC) to a lower operational voltage (12V AC). This PCB-mounted transformer is rated at 1-ampere and 12-volt. The resulting 12V AC is then fed into a bridge converter, which utilizes four rectifier diodes (specifically the 1N4007 type) to rectify the AC signal and convert it to Direct Current (DC). This bridge configuration is advantageous because it removes the need for an expensive center-tapped transformer. The diodes work in pairs; for instance, D1 and D3 handle the positive half cycle, while D2 and D4 handle the negative half cycle of the input AC signal. Following rectification, a filter capacitor is installed to smooth the AC output signal. Once the power is conditioned, the wireless power transfer stage begins. The input supply starts the implementation, and when applied, the Transistor (BD139) starts switching. This switching action, along with the help of a copper coil, generates the wireless power. The BD139 is an NPN transistor designed for medium power applications, such as driving loads up to 1.5A. It operates in forward bias when current is applied at the base terminal, requiring approximately 5V at the base-emitter pin. A number of transmitter copper coils are fixed beneath the road base, creating the time-varying electromagnetic field. The receiver copper coil, situated inside the Electric Vehicle (EV), receives this generated power across the air gap without any physical connection. The successful implementation of this design has resulted in less ripple in the input/output voltage and current.[7-9] The final operational phase involves managing the payment and vehicle exit, governed by an algorithm run via the IOT module Nodemcu and programmed using the Arduino IDE. After the vehicle traverses the charging road and the charging procedure concludes, the user is required to pay the accrued charging amount. This amount is displayed to the user on an LCD display (16x2). The IOT module, which functions as an open-source IOT platform, is crucial for networking and control. The algorithm initiates by enabling the LCD and the IOT module, configuring the Nodemcu as a server, searching for and automatically connecting with a network, and then displaying the IP address. The system waits for payment, which can be completed via a smartphone. Upon confirmation of successful payment, a GPIO signal is generated for the gate motor to open and close, thereby allowing the user to automatically exit the charging road. Furthermore, the system utilizes an Object Sensor (IR Sensor) as hardware. This sensor, which contains an IR LED transmitter and an IR photodiode receiver, works by detecting infrared radiation that reflects off nearby objects, enabling the system to sense aspects of the surroundings.[8][9]

V. HARDWARE REQUIREMENTS

A. microcontroller nodemcu

The below fig 2,NodeMCU is a small and affordable microcontroller board built around the ESP8266 Wi-Fi chip, designed especially for IoT projects. It comes with built-in Wi-Fi, several GPIO pins, and support for Arduino and Lua programming, making it easy to work with even for beginners. Because of its simple setup and strong community support, NodeMCU helps users quickly build practical applications

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Vol. 15 Issue 01 , January - 2026

like home automation, sensor monitoring, and smart devices. Its low power use, compact size, and flexibility make it a reliable choice for anyone looking to create connected, real-world solutions without much complexity.

B. LCD Display

the below fig 3, An LCD screen is an electronic display module that uses liquid crystal to produce a visible image. The 16×2 LCD display is a very basic module commonly used in DIYs and circuits. The 16×2 translates a display of 16 characters per line in 2 such lines. In this LCD, each character is displayed in a 5×7 pixel matrix.

C. Object sensor

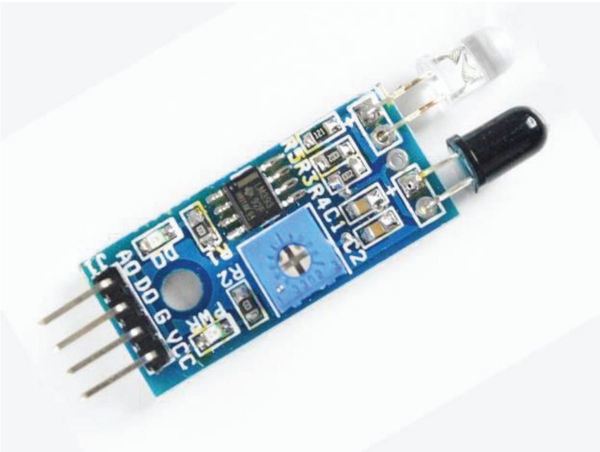

Fig. 2. object sensor

The above fig 2 is an object detector is a system designed to identify and locate specific items within an image or video. It doesn't just recognize what an object is but also marks its position using bounding boxes. These detectors use trained models to spot patterns, shapes, and features that distinguish one object from another. In everyday applications, object detectors help power technologies like self-driving cars, surveillance systems, robotics, and smart cameras. Their strength lies in processing visual information quickly and accurately, making them valuable for both safety and automation. Overall, an ob- ject detector makes machines more aware of their surroundings in a human-like way.

D. Transformer

A transformer is an electrical device used to transfer power between two circuits while changing voltage levels without altering frequency. It works on the principle of electromagnetic induction, using primary and secondary windings wrapped around a magnetic core. When alternating current flows through the primary coil, it creates a magnetic field that induces voltage in the secondary coil. Transformers help step voltage up for efficient long-distance transmission and step it down for safe use in homes and industries. They improve power quality, reduce losses, and ensure electrical systems run smoothly. In simple terms, a transformer safely bridges the gap between high and low voltage needs

E. Rectfier and filter

A rectifier is an electrical circuit that converts AC voltage into DC voltage, making it suitable for powering electronic devices. It uses diodes to allow current to flow in only one direction, producing a pulsating DC output. However, this output is not perfectly smooth, so a filter is added to improve it. Filters usually consist of capacitors and sometimes inductors, which store and release energy to reduce ripples in the voltage. Together, the rectifier and filter create a steady and reliable DC supply. This combination is commonly used in chargers, power supplies, and many household electronics to ensure safe and stable operation.

F. Motor

A motor is an electrical machine that converts electrical energy into mechanical motion. It works by creating a magnetic field inside the motor, causing the rotor to spin and produce useful movement. Motors come in many types—AC, DC, and stepper—each suited for different tasks. They power everyday devices like fans, pumps, appliances, robots, and industrial machinery. What makes a motor valuable is its ability to deliver smooth, continuous motion with high efficiency and reliability. In simple terms, a motor is the heart of any system that needs rotation or movement, helping machines perform real-world tasks effortlessly and consistently.

G. Transistor

A transistor is a small semiconductor device used to control or amplify electrical signals. It works like an electronic switch, allowing a tiny input current to control a much larger output current. Transistors are made from materials like silicon and have three terminals—base, collector, and emitter. They are widely used in circuits for switching, amplification, and signal processing. From radios and computers to power supplies and communication devices, transistors play a vital role in nearly all modern electronics. Their reliability, small size, and low power consumption make them essential building blocks that help bring electronic systems to life in a simple, efficient way.

H. Copper coil

A copper coil is simply a wire made of copper wound into a spiral shape, but it plays a powerful role in electrical and electronic systems. Because copper conducts electricity extremely well, the coil can easily create magnetic fields when current flows through it. This makes it useful in motors, transformers, inductors, and sensors. Copper coils help convert electrical energy into motion, store energy in magnetic form, or smooth out signals in circuits. Their durability, flexibility, and high conductivity make them a trusted choice in both small gadgets and large industrial machines. In everyday technology, copper coils quietly keep systems running smoothly and efficiently, Copper coil is shown below in fig 3.

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 15 Issue 01 , January - 2026

Fig. 3. Copper coil

I. LED

An LED, or Light Emitting Diode, is a small electronic component that produces light when current passes through it. Unlike traditional bulbs, LEDs do not rely on heating a filament, which makes them far more energy-efficient and long-lasting. They come in various colors and sizes, making them useful in indicators, displays, flashlights, and home lighting. LEDs stay cool, turn on instantly, and require very little power, which is why they are widely used in modern electronic devices. In simple terms, an LED is a tiny, reliable light source that helps brighten everything from gadgets to entire rooms while using minimal energy.

J. Arduino IDE

Fig. 4. Arduino IDE

Arduino IDE is shown in above fig 4, is a user-friendly software platform used to write, compile, and upload code to Arduino boards and compatible microcontrollers. It provides a simple interface where beginners can easily start programming using the Arduino language, which is based on C/C++. The IDE includes built-in libraries, examples, and tools that make connecting sensors, motors, and modules very easy. With just a USB cable, users can upload their programs directly to the board. Its clean layout, wide community support, and cross-platform availability make it a preferred choice for students, hobbyists, and makers. In short, Arduino IDE helps bring electronic ideas to life with simplicity and convenience.

K. Solar Panel

Solar panels convert sunlight into electricity, typically using photovoltaic cells. The generated electricity is sent to the vehicle's battery management system. The battery management system charges the vehicle's battery, supplementing the main charging source.This can increase the vehicle's range, reduce charging time, or power accessories. Benefits include reduced charging costs and emissions. However, efficiency and space limitations apply.

L. Battery

The battery pack consists of multiple cells, typically lithium-ion. When you accelerate, the battery sends electrical energy to the motor. The motor converts electrical energy into mechanical energy, propelling the vehicle. During braking, the motor acts as a generator, capturing kinetic energy and converting it back into electrical energy (regenerative braking). The battery is recharged via external power sources or regenerative braking. This cycle enables efficient, emission-free transportation. Battery health and range depend on factors like usage, charging habits, and maintenance.[10-12]

VI. Implementation details

The implementation of the dynamic wireless charging system for Electric Vehicles (EVs) is shown in below fig 5, divided into power preparation, transmission infrastructure, and an intelligent automated payment and exit sequence. The design relies on the core principle of dynamic wireless charging, which allows vehicles to receive a constant stream of energy across an air gap while in motion. This approach aims to alleviate range anxiety and decrease the need for massive onboard energy storage by utilizing the principle of magnetic induction. The initial stage focuses on the Power Supply section for conditioning the input utility power. The implementation starts with the supply as the input. A step- down transformer is critical, used to convert 230V AC to a lower 12V AC. This component is PCB mounted and rated at 1-ampere and 12-volt. The resulting AC signal is then fed into a bridge converter, which is formed using four rectifier diodes, specifically the 1N4007 type. This diode bridge configuration is chosen because it efficiently converts Alternating Current (AC) into Direct Current (DC) without requiring an expensive center-tapped transformer, thereby reducing system cost and size. During the conversion, diodes D1 and D3 handle the posi- tive half cycle, while D2 and D4 handle the negative half cycle

International Journal of Engineering Research & Technology (IJERT)
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Vol. 15 Issue 01 , January - 2026

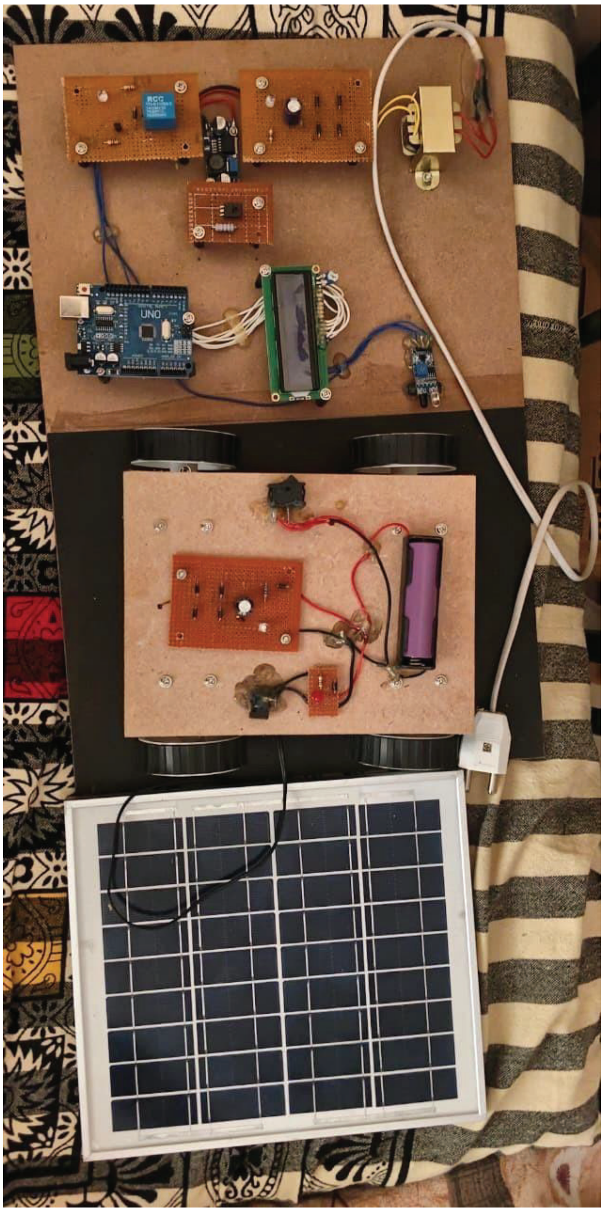

Fig. 5. Working model

of the input AC signal. A filter capacitor (C1) is subsequently installed to smooth the AC output signal. The successful design execution resulted in less ripple in input/output voltage and current while using low values of DC link and filter capacitance. For the wireless power transfer stage, the conditioned power is used to generate the electromagnetic field. Once the supply is applied, the Transistor (BD139) starts switching, which, with the assistance of a copper coil, generates the wireless power. The BD139 is an NPN transistor, designed as a medium power device capable of driving loads up to 1.5A. It operates in forward bias when approximately 5V of current is applied at its base terminal. A number of transmitter copper coils are fixed beneath the road base. The generated power is received by the receiver copper coil located inside the EV, accomplishing power transfer without any physical connection. The logistical management of the system is governed by a control algorithm run by the IOT module Nodemcu, which is programmed using the Arduino IDE. The Nodemcu functions as an open-source IOT platform. After the vehicle reaches the end of the charging road, the user must pay the charging amount, which is displayed on a 16x2 LCD display. The exit algorithm involves several steps: enabling the LCD and IOT module, configuring the Nodemcu as a server, searching for and automatically connecting with a network, and displaying the IP address. Payment can be made using a smartphone. The system utilizes an Object Sensor (IR Sensor), which contains an IR LED transmitter and an IR photodiode receiver, to sense aspects of the surroundings, typically detecting reflected infrared radiation. Once the system verifies the payment key press and successful transaction, a GPIO signal is generated for the gate motor to open and close, allowing the user to automatically exit the charging road.[13][14]

VII. COMPARISION

Fuels	Petrol	Diesel	EV
Cost/unit or Liter	102.92	95.7	6–10
Consumption	257.3	402.10	791.4 kWh
Range/year	828 km	1050 km	1258 km

TABLE I
FUEL COST, CONSUMPTION, AND RANGE COMPARISON

Fuel type	Petrol	Diesel	Electricity
Energy req	500 L	357 L	793 kWh
CO_2 emission	2347 g/L	2667 g/L	660.6 g/kWh
Annual rate (CO_2)	1173.5 kg	952 kg	52.38 kg

TABLE II
CO_2 EMISSION AND ANNUAL CARBON RATE COMPARISON

The above table 1 and table 2 compare petrol, diesel, and electric vehicles in terms of cost, energy consumption, yearly range, and environmental impact. Petrol and diesel vehicles show much higher fuel usage and running costs due to their dependence on fossil fuels, with petrol being slightly more expensive per litre. Electric vehicles, despite having a lower per-unit energy cost, require a significant amount of electricity annually, but their operating cost still remains far lower than conventional fuels. When it comes to range, EVs offer the highest yearly distance, followed by diesel and petrol. The environmental comparison clearly highlights the advantage of electric vehicles. Petrol and diesel emit substantial amounts of CO_2 each year, exceeding 1000 kg and 900 kg respectively, due to high carbon content in fossil fuels. In contrast, EVs produce only around 52 kg of CO_2 annually, making them a significantly cleaner and more sustainable option for long-term transportation.

VIII. RESULTS

The successful implementation of the proposed wireless electrical vehicle charging system yielded technical, operational, and environmental results, demonstrating a viable

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Vol. 15 Issue 01 , January - 2026

solution for dynamic wireless charging. A primary technical achievement was the efficiency and stability of the power preparation stage. The design resulted in less ripple in input/output voltage and current, which was achieved while utilizing a low value of DC link, and filter capacitance values. This efficiency is partly attributed to the chosen configuration of the power supply section, which utilized a step-down transformer to convert 230V AC to 12V AC and a bridge converter formed by four 1N4007 rectifier diodes. The bridge circuit configuration successfully converts Alternating Current (AC) into Direct Current (DC) without requiring an expensive center-tapped transformer, which reduces the system's cost and size. The operational wireless power transfer phase, facilitated by the switching action of the BD139 NPN transistor and copper coils, successfully enabled the receiver coil inside the EV to receive power across the air gap without any physical connection. Operationally, the system provides several key benefits by functioning as an Automatic system. The dynamic charging methodology itself allows EVs to charge on the go, meaning they do not need to stop to refuel or recharge. Instead, the vehicle receives a constant stream of energy across an air gap while in motion. This continual recharging while operating on roads and highways is a significant result because it could increase the vehicle's trip range. Furthermore, because vehicles can charge dynamically, there is less necessity for massive energy storage, resulting in the vehicle's weight being decreased. The result of implementing wireless charging technology is that EVs can utilize significantly smaller batteries, which reduces both the environmental impact and the cost associated with their introduction. The implementation also successfully integrated an intelligent payment and exit process, which functions as a Billing system. The final stages of the process demonstrated an Automatic exit gate controlled by an algorithm run via the IOT module Nodemcu. The system is designed to be Easy to use, Time saving, and Cost effective. Once the charging procedure is complete, the accrued charging amount is visible on an LCD display (16x2), and payment can be successfully executed using a smart phone. Upon successful payment, a GPIO signal is generated for the gate motor to open and close, enabling the user to automatically exit the charging road. The successful integration of these components allows vehicles equipped with this technology to become truly autonomous. In conclusion, the results show that this intelligent process for wireless charging addresses major challenges like range anxiety, paving the way for EVs to become a more viable option for widespread use. The system confirms that dynamic wireless charging is a viable way to overcome vehicle charging issues. Moreover, the electrification of roads with this charging capability will provide the necessary foundation for mass market penetration for EV regardless of battery generation. This system acts much like a moving sidewalk at an airport, where you can cover ground and recharge your energy simultaneously while remaining in motion, removing the need for frequent, stationary pit stops.[14][15]

IX. FUTURE SCOPE

1. Dynamic Charging Capability: Future developments can enable EVs to charge while in motion using embedded wireless transmitters in roads, supporting long-distance travel without stopping.
2. Integration with Smart Cities: The system can be integrated into smart city infrastructure, allowing coordinated energy distribution, real-time monitoring, and seamless user experiences.
3. Grid-Interactive Charging: The hybrid system can evolve to support bidirectional energy flow, enabling features like vehicle-to-grid (V2G) for better grid stability and energy sharing.
4. Scalability for Mass Deployment: The system can be scaled to power entire EV fleets, public transportation systems, or urban EV hubs with decentralized solar-powered wireless charging.
5. Enhanced Storage Solutions: Integration with next-generation energy storage technologies like solid-state batteries or supercapacitors could significantly improve energy retention and system lifespan.
6. AI-Powered Charging Optimization: Artificial intelligence can be used to predict charging demands, optimize energy routing, and adjust wireless charging parameters in real time.
7. Wireless Charging Standardization: The technology can help shape global standards for interoperable wireless charging systems across different EV models and manufacturers.
8. Portable and Emergency Charging Units: Future designs could include mobile or trailer-mounted hybrid chargers for use in remote areas, emergencies, or disaster response situa- tions.
9. IoT and Cloud Integration: Real-time data collection and cloud-based analytics can enable remote diagnostics, predictive maintenance, and energy usage reporting.
10. Advanced Materials for Efficiency: Research into more efficient solar cells (e.g., perovskite) and WPT components (e.g., high-Q factor coils) can significantly enhance the system's performance.
11. Powering while at the same time driving On-street/dynamic controlling of EVs is the condition of- workmanship advancement in future EV charging. The constrained scope of EVs can be charge wirelessly. In future we can add many other things in this project. In future with minimum changes, we can modify this project without any trouble. In future this research will be increase, as EV vehicle increasing day by day.

X. CONCLUSION

The implementation of the wireless electrical vehicle charging system provides a compelling conclusion regarding the feasibility and benefits of dynamic power transfer for the transportation sector. The project successfully presented a design for wireless charging of Electric Vehicles (EVs), demonstrating that dynamic wireless charging is a viable way to overcome vehicle charging issues such as range anxiety and the reluctance to spend significant time charging batteries on long trips. The objective of allowing EVs to charge on the go, receiving a constant stream of energy across an air gap while in motion using the principle of magnetic induction, was achieved. This approach is crucial given that automobile electrification is unavoidable due to environmental concerns and the necessity of reducing dependency on crude oil, positioning EVs as an effective component in a sustainable transportation system. A significant outcome of this intelligent process is the resulting technical efficiency and operational ease. The successful design execution resulted in less ripple in input/output voltage and current, which was accomplished while utilizing a low value of DC link, and filter capacitance values. The system effectively manages power conversion using a step-down transformer (converting 230V AC to 12V AC) and a bridge converter (using four 1N4007 diodes) to efficiently produce Direct Current (DC) without requiring an expensive center-tapped transformer. The wireless power transfer relies on the switching action of the BD139 NPN transistor and multiple transmitter copper coils fixed beneath the road base, allowing the receiver copper coil in the EV to receive power without any physical connection. Operationally, the technology offers many benefits compared with wired charging, including increased mobility, convenience, and safety. The continual recharging while operating on roads and highways could significantly increase the vehicle's trip range. Beyond power transfer, the system successfully implemented an automated, integrated logistical process, functioning as an Automatic system with a Billing system and an automatic exit gate. The algorithm, run by the IOT module Nodemcu and programmed using the Arduino IDE, enables the dis- play of the charging amount on an LCD Display (16X2) and facilitates payment via a smart phone. Upon successful payment, a GPIO signal is generated for the gate motor to open and close, allowing automatic vehicle exit. Crucially, the implementation of wireless charging technology on the go enables EVs to utilize significantly smaller batteries, as there is less necessity for massive energy storage, thereby decreasing the vehicle's weight. This outcome reduces both the environmental impact and the cost of introducing EVs, making them more viable for widespread use and enabling them to become truly autonomous. The conclusion asserts that when roads are electrified with wireless charging capability, it will provide the necessary foundation for mass market penetration for EV regardless of battery generation, moving towards the state-of-the-art advancement of on-street/dynamic controlling of EVs. While wireless charging of EVs can be brought to fruition with ongoing technology development, further studies in topology and design management are needed in the near term.

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