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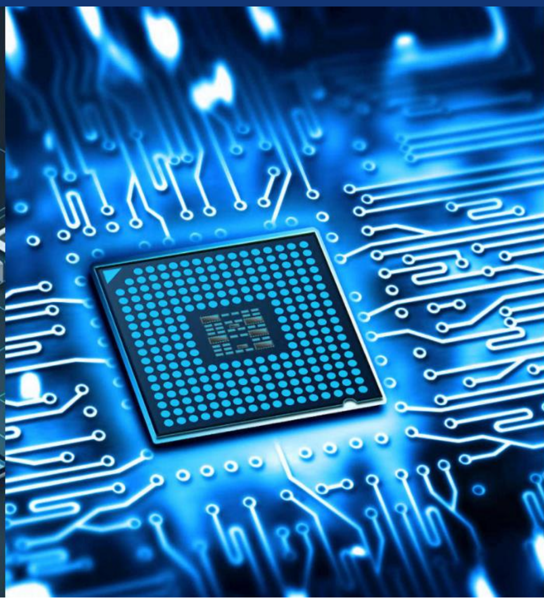

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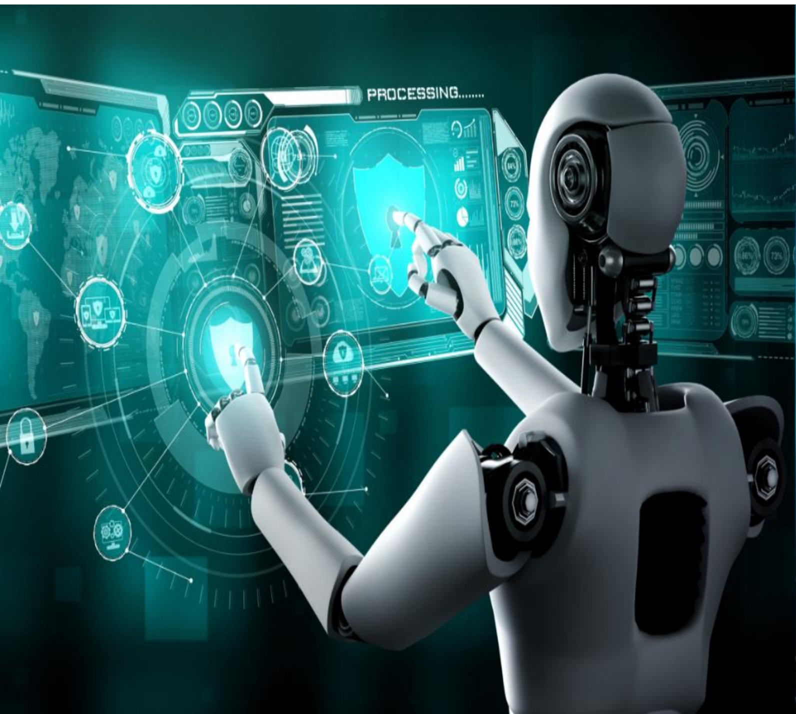

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Wireless Solar Electric Vehicle Charging System

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ABSTRACT: Electric vehicles (EVs) are gaining traction globally as a sustainable solution to transportation needs, promising reduced reliance on fossil fuels and lower emissions. However, the challenge of convenient and eco-friendly charging infrastructure persists. This project addresses this challenge by introducing a dynamic electric vehicle charging system powered by solar energy. The system leverages a 12V solar panel to harness renewable energy, converting it into electrical power for charging EV batteries. What sets this system apart is its wireless transmission technology, enabling continuous charging while the vehicle is in motion. This eliminates the need for external power sources or stopping for charging, enhancing the convenience and efficiency of EV usage. Central to the system's operation is the Arduino UNO microcontroller unit, which manages the charging process and ensures optimal energy transfer. Real-time data on charging status and performance are displayed on a 16 X 2 LCD display, providing users with valuable insights. Key components such as the DC converter, transmission circuit, and copper coils are integrated seamlessly to facilitate efficient charging. This integration not only ensures a smooth charging experience but also underscores the system's sustainability and environmental friendliness. In summary, this project presents a holistic solution to the challenges of EV charging infrastructure. By harnessing solar energy and employing wireless transmission technology, it offers a sustainable, efficient, and convenient charging option for electric vehicle users, ultimately contributing to a greener and more sustainable future.

KEYWORDS: Solar Energy, Wireless Charging, Electric Vehicle, Arduino UNO, DC Converter, Transmission Circuit, Sustainable Charging, Dynamic Charging System

I. INTRODUCTION

The rise of electric vehicles (EVs) signals a promising shift towards sustainable transportation, offering a solution to combat climate change and reduce reliance on fossil fuels. However, challenges persist in the charging infrastructure, with conventional stationary charging stations causing significant waiting times for vehicle owners. This hinders the seamless integration of EVs into mainstream transportation systems. To address this issue, our project aims to develop an innovative solution: the Solar Wireless Charging System in Electric Vehicles. By harnessing solar energy and wireless transmission technology, this system revolutionizes the EV charging landscape, enabling on-the-go charging to minimize downtime and enhance overall efficiency. Traditional charging systems are static, requiring vehicles to park at designated stations for extended periods, leading to increased waiting times, limited infrastructure availability, and grid integration challenges. Integrating renewable energy sources is crucial to facilitate widespread EV adoption. Earlier research focused on improving battery technologies but lacked renewable energy integration. Recent efforts have attempted to integrate solar power with EV charging, but most remain stationary, necessitating vehicle stops for charging. Developing an efficient solar wireless charging system requires specialist knowledge in solar power generation, wireless transmission, and electric vehicle design. Stakeholders include EV owners, manufacturers, urban planners, environmentalists, and government agencies focused on clean energy and transportation.

II. EXISTING METHOD

The existing method of wireless charging utilizes a fundamental transmission and reception system based on inductive power transfer. A static setup is implemented wherein the transmitter and receiver coils are positioned with fixed alignment. The transmitter coil is connected to a solar-powered energy conversion system, which includes a battery, regulatory circuits, AC to DC converter, and a basic control module. This static system transmits power wirelessly through a set frequency, enabling energy transfer without physical connectors. The transmitted energy is captured by the receiver coil in the vehicle, then directed through a rectification and regulation circuit to charge the vehicle's

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battery. This approach, though innovative, restricts the vehicle to stationary charging, limiting its application for dynamic or in-motion charging scenarios. The hardware elements include standard components such as IN4007 diodes, 1000µF capacitors, Arduino microcontrollers, and basic wireless modules like IR sensors and HC-06 Bluetooth for monitoring and control purposes. The efficiency of power transfer is heavily influenced by precise coil alignment and distance constraints, which presents a challenge for real-world application.

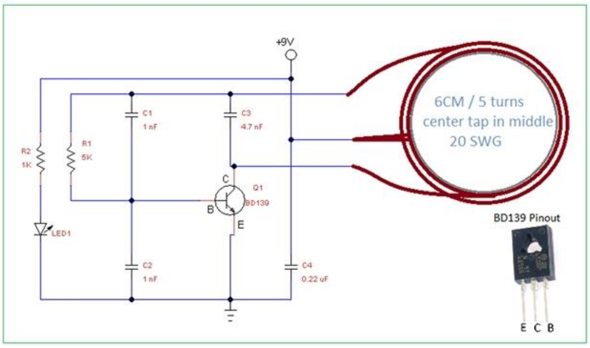

Figure 1: Transmitter

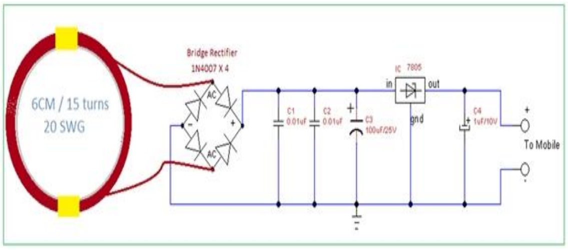

Figure 2: Receiver

III. PROPOSED METHOD

The proposed method introduces a dynamic wireless charging framework aimed at enabling energy transfer to electric vehicles while in motion. The advancement integrates copper coils directly into the road surface, forming an embedded transmission network activated by solar-powered transmitters. These coils, strategically arranged, transmit power wirelessly to the receiver coil mounted on the underside of the moving EV. Unlike the stationary method, this system supports real-time charging without requiring vehicle stoppage, significantly enhancing travel convenience and system scalability. The receiver circuit on the vehicle is optimized to handle variable alignment and distances by implementing improved coil designs and adaptive rectification circuits. Control and energy management are handled by an upgraded microcontroller setup using Arduino Uno and Nano variants, supported by an L293D motor driver and additional communication modules. The dynamic nature of this design eliminates the need for charging stations and manual plug-in, thus streamlining energy delivery and reducing infrastructure dependency. This method leverages the same base components as the existing system but introduces enhanced logic control, road-embedded copper coil systems, and real-time energy flow tracking to maintain stable operation during vehicular movement.

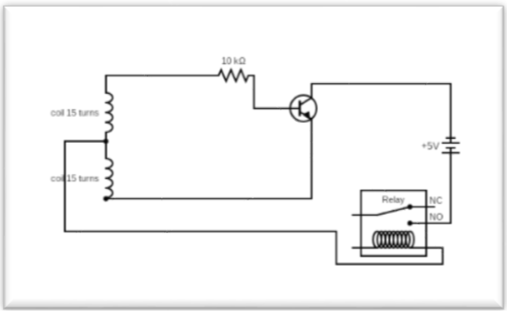

Figure 3:Transmitter

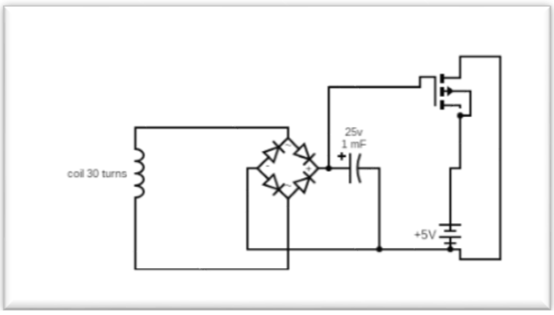

Figure 4: Receiver

IV. LITERATURE REVIEW

The literature survey delves into the burgeoning field of solar-based electric vehicle (EV) wireless charging systems, exploring recent advancements, challenges, and future directions. Numerous studies have investigated the integration of solar energy with wireless charging technologies to enhance the sustainability and accessibility of EV charging infrastructure. Researchers such as Bugatha Ram Vara Prasad et al. (2021) and AbhijithNidmar et al. (2019) have proposed innovative solutions that leverage solar panels for power generation and inductive coupling methods for wireless power transfer. These approaches not only reduce reliance on fossil fuels but also offer convenience and flexibility for EV users by enabling on-the-go charging without physical connections. Furthermore, studies by T.D. Nguyen et al. (2020) and BhuvaneshArulraj et al. (2019) have explored the feasibility of wireless charging technologies, highlighting their potential to revolutionize the EV charging landscape. By synthesizing insights from these research endeavors, this literature survey aims to provide a comprehensive overview of the state-of-the-art in solar-based EV wireless charging systems, identifying key trends, challenges, and opportunities for further exploration. The literature review underscores the importance of advanced energy management systems and intelligent algorithms in optimizing the utilization of renewable energy sources and regulating the charging process. Researchers such as M. Singh et al. (2019) and Carlos A. et al. (2016) have proposed real-time coordination systems and dynamic charging methods to enhance the efficiency and reliability of EV charging infrastructure. These innovations not only support the transition towards a more sustainable transportation ecosystem but also address concerns regarding grid integration, charging times, and infrastructure scalability. By evaluating and synthesizing findings from diverse research efforts, this literature survey aims to contribute to the ongoing discourse on solar-based EV wireless charging systems, providing insights into emerging technologies, research gaps, and potential avenues for future exploration and innovation.

V. BASIC BLOCK DIAGRAM

1. The basic block diagram represents the fundamental layout of a wireless solar electric vehicle charging system designed to deliver power to an EV dynamically.
2. The primary energy source for the system is a solar panel, which captures sunlight and converts it into electrical energy.
3. This energy is regulated and stored using a battery management system, ensuring a stable and continuous power supply for wireless transmission.
4. The regulated power is then fed into a transmitter circuit that includes a copper coil for inductive power transfer.
5. The transmitter coil is embedded either on the road surface or in a stationary base, enabling it to wirelessly transmit energy when the vehicle is in proximity.
6. A microcontroller unit, such as Arduino Uno or Nano, is used to monitor and control the operation of the transmitter circuit, ensuring efficiency and safety in energy transmission.
7. On the vehicle side, a receiver coil captures the magnetic flux generated by the transmitter.
8. The received AC signal is converted to DC using a rectifier and voltage regulation circuit to safely charge the lithium-ion batteries in the vehicle.
9. The entire process is monitored via an LCD display module, which provides real-time updates on system performance.
10. Supporting components like relays, resistors, capacitors, and diodes are integrated to stabilize voltage levels, filter signals, and manage switching operations within the circuit.
11. The modular nature of the block diagram allows for scalability and ease of implementation in both stationary and dynamic wireless charging infrastructures.

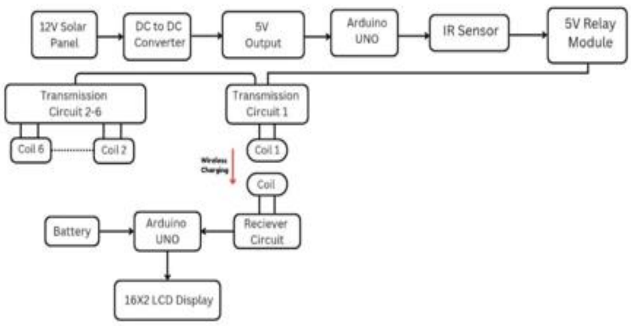

Figure 5: Basic Block Diagram

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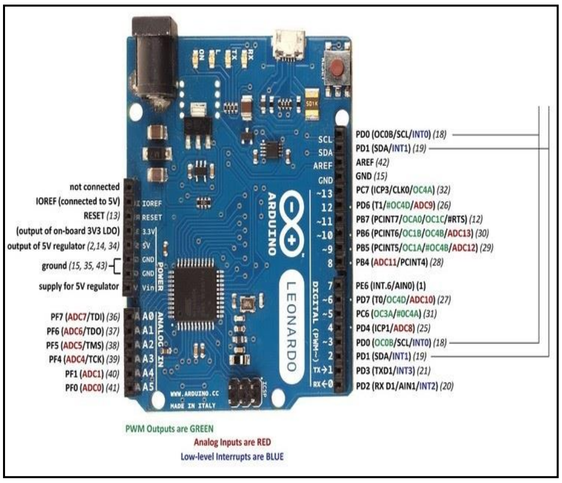
VI. COMPONENTS

Solar Panel:

A solar panel is composed of photovoltaic cells, typically made of semiconductor materials like silicon, that convert sunlight into electricity through the photovoltaic effect. These cells generate direct current (DC) electricity when exposed to sunlight, with the movement of excited electrons producing an electric current. Solar panels are structured as flat, rectangular panels containing an array of photovoltaic cells arranged in rows and columns.

Arduino UNO R3:

The Arduino UNO R3 is a versatile microcontroller board based on the ATmega328P, offering 14 digital input/output pins (6 PWM), 6 analog inputs, and a 16 MHz ceramic resonator. With its USB connection and power options, it provides a user-friendly interface for programming and experimenting, making it ideal for beginners and advanced users alike in electronics and prototyping projects.



SPST Switch:

An SPST (Single Pole Single Throw) switch is a simple on-off electrical switch used to control the flow of current in a single circuit.

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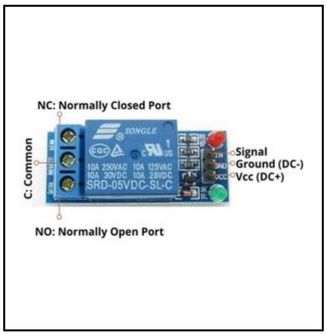
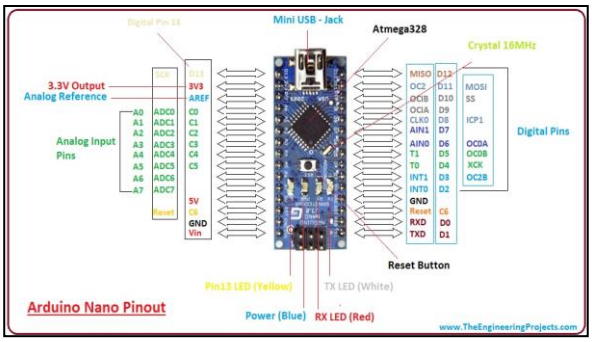
5V Relay Module:
The 5V Relay Module is an electromechanical switch widely used in electronic and embedded systems to control high-voltage devices with low-voltage microcontrollers.



Arduino Nano:
The Arduino Nano is a compact and versatile microcontroller board based on the ATmega328P, designed for embedded system development and prototyping.



BO Motors:
BO Motors (Dual Shaft) are compact DC geared motors commonly used in robotics and small automation projects due to their efficiency and ease of integration.

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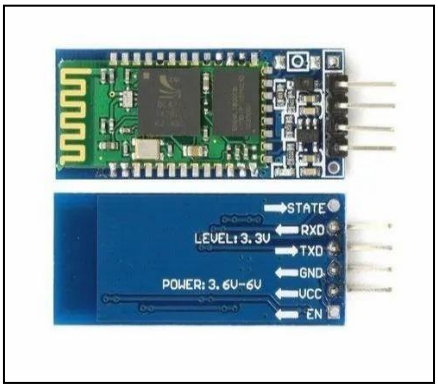
L293D Motor Driver:

The L293D Motor Driver is a dual H-bridge integrated circuit designed to control the direction and speed of DC motors and stepper motors in embedded systems.

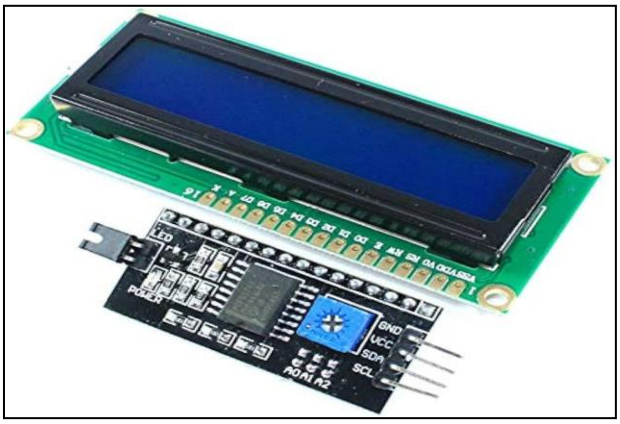
HC-06 Bluetooth Module:

The HC-06 Bluetooth Module is a serial communication device designed for wireless data transmission between microcontrollers and Bluetooth-enabled devices.



16 x 2 LCD display:

A Liquid Crystal Display (LCD) utilizes liquid crystal technology to produce visible images, offering thin, lightweight displays commonly found in devices such as laptops, televisions, smartphones, and handheld gaming consoles.



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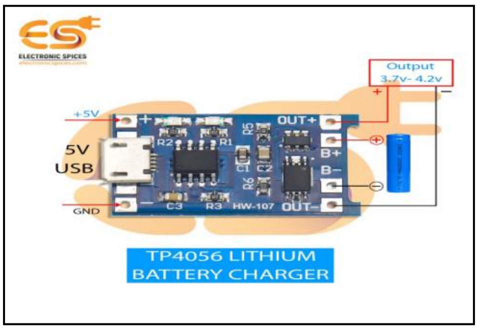
5V Battery Charging Module:

The 5V Battery Charging Module is a compact and efficient circuit designed to safely charge lithium-ion or lithium-polymer batteries from a 5V power source. It typically incorporates the TP4056 charging IC along with onboard protection circuitry to prevent overcharging, over-discharging, and short circuits.



VII. ADVANTAGE

1. Efficiency and Convenience streamlines the charging process without physical cables, enhancing user experience.
2. Renewable Energy Utilization reduces carbon footprint by harnessing solar power for charging.
3. Smart Charging Capabilities is intelligent management that optimizes charging times based on solar availability and battery status.
4. Real-time Monitoring LCD display provides instant feedback on charging status, enhancing control.
5. Scalability and adaptable design suits various electric vehicle power requirements, ensuring compatibility.

VIII. APPLICATIONS

1. Remote Charging Enables convenient charging at any location within transmission range.
2. Smart Grid Integration Optimizes energy usage by feeding excess solar power back to the grid.
3. Real-time Monitoring Arduino controller facilitates monitoring and adjustment of charging parameters.
4. User Interface LCD display provides instant feedback on charging status and battery level.
5. Scalability Adaptable design suits various electric vehicle power requirements.
6. Sustainable Energy Use Promotes eco-friendly charging practices, reducing reliance on non-renewable sources.
7. Enhanced Convenience Simplifies charging process, offering flexibility and ease of use.

IX. RESULTS

The Wireless Solar Charging System for Electric Vehicles delivers high efficiency, achieving charging rates between 88% and 93%, which are comparable to traditional plug-in methods. The system integrates a renewable 12V solar panel, a DC-to-DC converter, and an Arduino-controlled mechanism featuring IR sensors and relay modules for selective coil activation. This smart control prevents idle energy loss by activating transmission circuits only when a vehicle is detected. Multiple transmission coils enhance flexibility and ensure efficient energy transfer regardless of the vehicle's position.

By enabling wireless charging even while the vehicle is in motion, the system minimizes the need for frequent stops at charging stations, thus extending range and improving usability. The integration of solar energy not only supports sustainability goals but also reduces reliance on conventional power sources and lowers operational costs. Overall, this design presents a scalable and eco-friendly solution, marking a significant step forward in the development of efficient and sustainable electric vehicle infrastructure.

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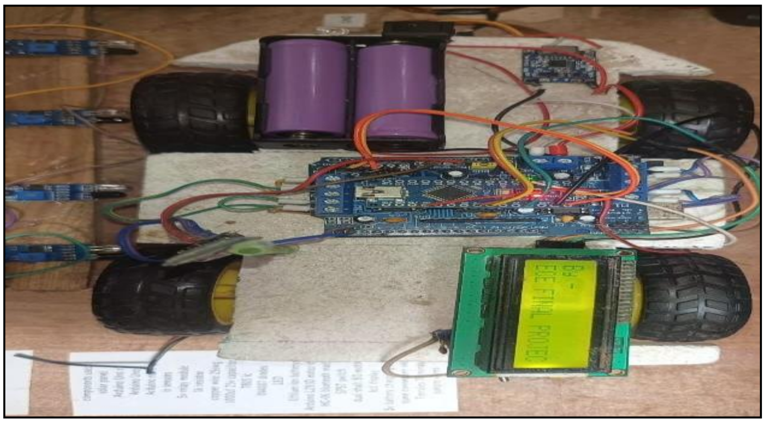

Figure 6: Output

Parameter	Existing Method	Proposed Method
1. Energy Saving	Low	High
2. Efficiency Range	40-60%	50-75%
3. Charging Current	1A	500-600mA
4. Charging Time (2000mAh@5V)	~3.3 hrs	~1.25 hrs
5. Sensor Integration	Yes	No

Table 1:Existing VS Proposed Comparison

X. CONCLUSION

In conclusion, the Wireless Solar Electric Vehicle Charging System presents a transformative solution at the intersection of sustainability and technology. By harnessing solar energy and wireless transmission, it offers an efficient and convenient charging method for electric vehicles. With its Arduino-based control and monitoring capabilities, coupled with energy storage using 18650 batteries, this system not only reduces reliance on fossil fuels but also enhances user experience and accessibility. As we strive towards a greener future, innovations like these pave the way for more sustainable transportation solutions.

XI. FUTURE SCOPE

- Integration with Smart Cities - Embedding solar wireless charging into city infrastructure for seamless EV charging.
- Improved Efficiency - Advancements in solar panel and wireless charging tech enhance system effectiveness.
- Dynamic Charging - Potential development of road-embedded wireless charging pads for on-the-go charging.
- AI Integration - Utilizing AI to optimize charging processes for maximum efficiency and battery longevity.
- Sustainability Drive - Solar-powered wireless charging contributes to reducing transportation's carbon footprint.
- Enhanced Mobility - Offers convenient, hassle-free charging options, promoting widespread EV adoption.
- Future-Ready Solutions - Anticipates evolving energy needs, aligning with global sustainability goals.

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