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On Road EV Vehicle Charging for Smart City

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***Abstract*-Currently, the electric vehicle industry is undergoing rapid changes. The technology has been upgraded from the one we had ten years ago. In addition to our progress, we have also encountered some new problems that are hindering the growth of the new electric vehicle market. This new technology of wireless electric charging for electric cars is not unique to India, but it is already in use elsewhere. As part of this technology, an electric current is transferred by creating a magnetic field between a transmitting pad on the ground and a receiving pad under the vehicle. It is estimated that this system is more than 90% efficient while charging. It is through this technology that any electric vehicle may be recharged while operating on the highway. Most importantly, this technology will offer contact-free dynamic charging up to 110 km/hr for vehicles. WiTricity will contribute to the technological advancements necessary for automakers to provide a quick and effective EV charging experience. EV drivers will be able to recharge handsfree without the use of any cumbersome cords by just parking over wireless charging ground pads that are installed at homes, in garages, and public parking lots.**

I.INTRODUCTION

As smart cities worldwide strive for sustainability and reduced carbon emissions, the adoption of electric vehicles (EVs) is playing a pivotal role. However, a key challenge in promoting widespread EV usage is the development of a convenient and efficient charging infrastructure. While traditional charging stations are essential, innovative solutions like on-road EV charging are emerging as a promising technology for smart cities.

On-road EV charging, also known as dynamic wireless power transfer (DWPT), allows electric vehicles to charge wirelessly while in motion or when stationary over a charging-enabled road surface. This technology has the potential to revolutionize EV usage in smart cities by addressing range anxiety, optimizing energy consumption, and contributing to a more seamless and sustainable transportation ecosystem.

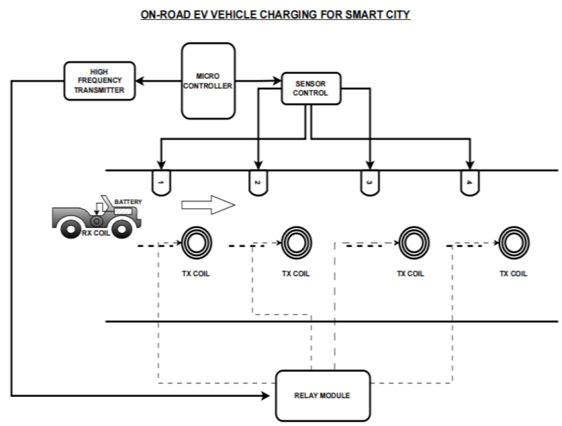

Fig : ON-ROAD EV VEHICLE CHARGING FOR SMART CITY

smart city technologies and initiatives, such as smart traffic management, autonomous vehicles, and connected infrastructure. This interconnectedness can lead to more efficient traffic flow, optimized energy distribution, and enhanced overall urban mobility.
ensuring uninterrupted operation.

Potential for Inductive and Conductive Technologies: On-road charging can be achieved through wireless inductive charging, where energy is transferred via electromagnetic fields between coils embedded in the road and the vehicle, or through conductive charging, using physical contact with charging rails or plates embedded in the road. Both technologies are being explored and developed for practical implementation.

II. PROCEDURE

On-road EV charging in a smart city involves a complex interplay of technology, infrastructure, and user interaction. The exact procedure can vary depending on the specific technology implemented (inductive or conductive) and the city's infrastructure. However, a general overview of the process can be described as follows:

General Procedure for On-Road EV Charging:
1: City Infrastructure Deployment:
Installation of Charging Technology: The smart city authority or private providers will install the necessary charging infrastructure within designated road sections.

Inductive Charging: This involves embedding wireless power transfer coils beneath the road surface. These coils are connected to the power grid and generate a magnetic field when energized.

Conductive Charging: This involves installing conductive rails or plates on or within the road surface. These are also connected to the power grid.

Grid Integration: The on-road charging infrastructure is integrated with the smart grid to manage energy distribution, optimize charging times (e.g., during off-peak hours), and potentially utilize renewable energy sources.

Communication and Control Systems: Smart sensors and communication networks are deployed to monitor the charging infrastructure, detect vehicle presence, manage power transfer, and handle billing
.
2: Vehicle Compatibility:
Equipping EVs: Electric vehicles intended to use on-road charging need to be equipped with compatible receivers.

Inductive Charging: Vehicles require a receiving coil mounted on their undercarriage, aligned with the transmitting coils in the road.

Conductive Charging: Vehicles need a retractable connector or a pantograph that can make contact with the conductive rails or overhead wires in the road.

3: Charging Process While Driving (Dynamic Charging):
Vehicle Detection and Activation: As a compatible EV drives over a charging-enabled road section, sensors in the road detect its presence and activate the corresponding charging segments. In some inductive systems, only the coils directly beneath the vehicle are energized to improve efficiency and safety.

Fig : Electric re-charging lane

4: Power Transfer:
Inductive: The magnetic field generated by the transmitting coils in the road induces an electric current in the receiving coil of the EV. This current is then converted and used to charge the vehicle's battery.
Conductive: The vehicle's connector makes physical contact with the conductive rails or wires, allowing electricity to flow directly to the vehicle's motor and battery.
e updates on power usage and remaining balance might be available through a mobile app.

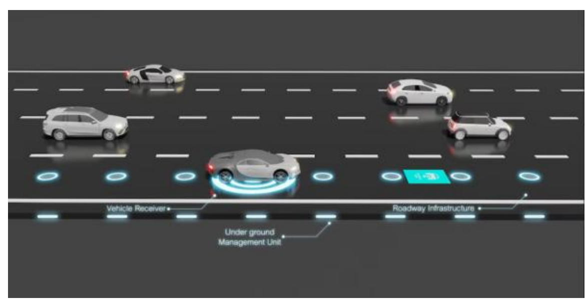

Fig : Smart charging technology in smart city

5.Conductive On-Road Charging:
a) Power Transfer:
The power transferred (Ptransfer) in a conductive charging system is primarily determined by the voltage (V) supplied by the road infrastructure and the current (I) drawn by the vehicle:
$\text{Ptransfer}=V\times I$
b) Energy Consumption:
Similar to inductive charging, the energy consumed over a distance d at an average power Pavg and speed v is:
$\text{Echarged}\approx \text{Pavg}\times vd$
c) Efficiency of Power Transfer (η):

The efficiency of conductive power transfer is generally higher than inductive, primarily limited by resistive losses in the cables and contact points:

η=PinPload=Vsupply×IsupplyVvehicle×Ivehicle

Where Vvehicle and Ivehicle are the voltage and current at the vehicle's battery, and Vsupply and Isupply are from the road infrastructure.

d) Force and Friction:

For systems involving physical contact (like pantographs), mechanical considerations such as the force (F) required for contact and the frictional losses (Pfriction=F×vcontact, where vcontact is the relative velocity at the contact point) might need to be modeled, although these typically have a smaller impact on the overall energy transfer efficiency compared to electrical losses.

6. Smart City Level Modeling:

At the smart city level, mathematical models can be used for:

Optimizing Placement of Charging Infrastructure: This involves considering traffic flow (Q(x,t)), EV density (ρEV(x,t)), average trip distances, and energy demand to strategically place charging segments. Optimization functions could aim to minimize infrastructure cost while maximizing accessibility and utilization.

Dynamic Power Management: Algorithms can be developed to dynamically allocate power to different charging segments based on the number and charging needs of EVs present, while also considering grid stability and energy prices. This might involve complex optimization problems with constraints on power availability and charging rates.

Traffic Flow and Energy Consumption Modeling: Integrating EV charging into traffic flow models can help predict the impact on congestion and overall energy demand within the city. This could involve agent-based modeling or macroscopic traffic flow equations incorporating EV charging behavior.

III. WORKING PRINCIPLE

The idea project consists of IR sensors and coils, when the ir sensor is triggered when car comes, the coil below the vehicle is activated through relay and charging of the vehicle starts.

Dynamic wireless charging system form road to vehicle is proposed using Arduino, IR sensor and relays.

The method uses Electromagnetic Induction, a fundamental concept in magnetism, to induce current through two copper coils.

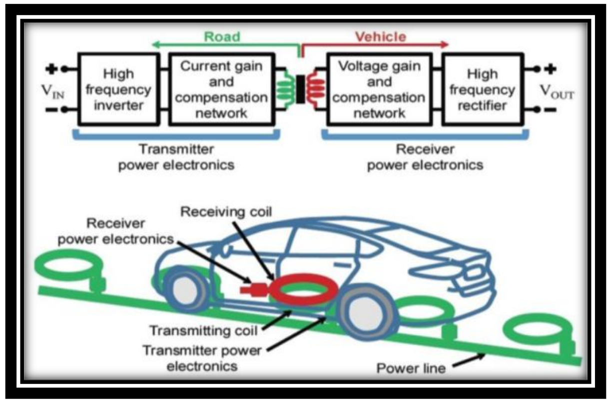

Fig: Working Principle

One is located on the vehicle's lower chassis and is referred to as the main coil, while the other is located on the road just under its surface and is referred to as the subordinate coil.

IV.HARDWARE AND SOFTWARE SPECIFICATIONS

HARDWARE SPECIFICATION

Esp32 Microcontroller

Power supply DC-DC Converter

IR sensor

High frequency inverter

Tx Rx coils

Relay switch

L293d motor drive

Vehicle

SOFTWARE SPECIFICATION

Operating System: Windows

Platform: Arduino IDE

Languages: embedded C language

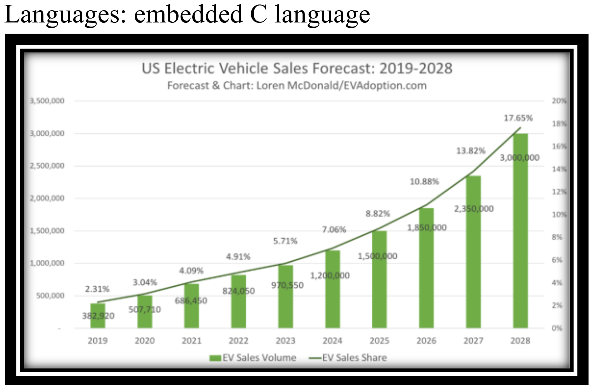

Fig : Graphical Representation of EV Vehicles

V. CONCLUSION

In conclusion, the "Energy Tapping Identifier Through Wireless Data Acquisition System" offers an effective and economical solution for detecting unauthorized electricity usage, particularly in rural and agricultural areas. By employing current transformers at both ends of a transmission line segment and utilizing wireless communication (e.g., Zigbee), the system monitors and compares current flow to identify discrepancies indicative of energy tapping. When a significant difference in current readings is detected (typically exceeding 3-4%), an alarm is triggered, promptly notifying authorities of potential energy theft. This approach enhances real-time monitoring, reduces manual inspection efforts, and supports the integrity and reliability of power distribution networks.

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