WIRELESS POWER TRANSFER FOR CHARGING OF ELECTRIC VEHICLES

Project report submitted

in partial fulfillment for the degree of

B.Tech. in Electronics and Communication Engineering

Submitted by

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Bhubaneswar, Odisha, India.

(June, 2023)

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I would like to take this opportunity to offer my deepest gratitude and appreciation to my distinguished supervisor, Professor Sabita Mali, for her tremendous guidance, steadfast support, and mentorship during my academic path in the field of Electronic and Communication Engineering. Her vast knowledge, passion, and skill have been critical in moulding my research and personal development.

Professor Sabita Mali, for her ongoing availability, constructive input, and support, is highly appreciated. Her advice and comments have greatly aided in the refining and quality of my work. Her enthusiasm for the subject and commitment to perfection have been a constant source of inspiration for me, pushing me to go beyond my comfort zone and aim for the greatest standards.

I would also like to express my heartfelt gratitude to my amazing team members, whose collaborative efforts and unwavering devotion were critical to the successful completion of our project. Their technical expertise, professionalism, and teamwork have created a dynamic and productive work atmosphere in which ideas have been shared, difficulties have been solved, and goals have been met.

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In conclusion, I am deeply indebted to Professor Sabita Mali for her exceptional guidance, my team member(s) for their outstanding collaboration, and the faculty members of the Electronic and Communication Engineering department for their support. Their contributions have been invaluable in shaping my academic journey, and I am truly grateful for the opportunity to work with such exceptional individuals.

Signature of students with date

ABSTRACT

Purpose :

To make the world free from pollutant emissions caused by nonrenewable fueled vehicles and to provide the alternative to costly fuel for transportation the world has now shifted to Electric Vehicles (EVs). The world will be safe from not getting polluted by sound pollution, carbon monoxide pollution, fuel expense and also, we can get clean cities and places. The daily travel expenses of individuals can be less by using electric vehicles.

Design/methodology/approach:

Wireless power transfer system (WPTS) for charging of Electric vehicles (EVs) can be classified into static charging, when the vehicle is at stationary and nobody is inside it but this is very time consuming and requires human input. Another is dynamic charging, it can easily get charged from the road while moving. In this research we design a dynamic mode of charging for Electric vehicle. It requires a powerful transmitting coil and a receiving coil to transfer power. The transmitting coil is embedded on the roads and each electric vehicle will be equipped with a receiving coil that will charge its battery by capturing the transmitted power using induced coupling.

Findings:

Our findings demonstrate that the model is reliable and its performance can be improved by lowering the vehicle's ground clearance. However, we found that problems can be addressed because of the vehicle's high weight, high speed and restricted driving area.

Research limitations/implications:

This dynamic mode of charging model is very challenging for real world implementation. It cannot be used for long routes because a lot of copper wires will be needed which is not cost efficient. And the best possible place for this implementation is only the traffic signals or inside the city because the road's transmitting coil and the vehicle's receiving coil are needed to be coupled properly for charging and it is not possible if the vehicles are too fast. Also, this dynamic mode of charging while moving in a road is much slower than the static stationary charging.

Originality/value :

Electric Vehicles (EVs) is fully dependent on plug in mode of charging and get easily discharged and there is a drastic difference between the number of EVs sale and the number of charging stations. So, it is very difficult to find a charging station near us. The entire world is waiting for a proper technology or solution for this static charging problem. So, if we implement this idea of charging while moving in a road, the entire world will be our customer.

Keywords: Electric Vehicles, Wireless power transfer system (WPTS), Induced coupling, Static Charging, Dynamic Charging

DECLARATION

We declare that this written submission represents our ideas in our own words and where other'sideas or words have been included, we have adequately cited and referenced the original sources.We also declare that we have adhered to all principles of academic honesty and integrity and havenot misrepresented or fabricated or falsified any idea/fact/source in our submission.

We understand that any violation of the above will be cause for disciplinary action by theUniversity and can also evoke penal action from the sources which have thus not been properlycited or from whom proper permission has not been taken when needed.

Signature of students with Registration Numbers

Date: ____________

CERTIFICATE

This is to certify that the project entitled **WIRELESS POWER TRANSFER FOR CHARGING OF ELECTRIC VEHICLES** being submitted by ***(Shubhani Arunashree, Snehashisa Subudhiratna, ECE, Sec-B)*** to the Institute of Technical Education and Research, Faculty of Engineering &Technology, Siksha'O'Anusandhan(Deemed to be University), Bhubaneswar for the partial fulfilment for the degree of B.Tech. in Electronics and Communication Engineering is a record of bonafide work carried out by them under my/our supervision and guidance. The project work, in my/our opinion, has reached the requisite standard fulfilling the requirements for the degree of Bachelor of Technology. The results contained in this thesis have not been submitted in part or full to any other University or Institute for the award of any degree of diploma.

(Signature of Supervisor(s) with name and date)

Department of Electronics and Communication Engineering

Institute of Technical Education & Research (Faculty of Engineering & Technology)

Siksha 'O' Anusandhan

(Deemed to be University)

REPORT APPROVAL

This project entitled " **WIRELESS POWER TRANSFER FOR CHARGING OF ELECTRIC VEHICLES** " by (Shubhani Arunashree , Snehashisa Subudhiratna) is approved for the degree of B. Tech. in Electronics and Communication Engineering.

Examiners signature with name

Supervisor signature with name

Date:

Place:

EDP Chairman's signature with name

(Departmental Seal)

CONTENTS

WPT - **PLAGIARISM CHECK CERTIFICATE**

ORIGINALITY REPORT

3%	0%	2%	1%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	Manuele Bertoluzzo, Mude Kishore Naik, Giuseppe Buja. "Preliminary investigation on contactless energy transfer for electric vehicle battery recharging", 2012 IEEE 7th International Conference on Industrial and Information Systems (ICIIS), 2012 Publication	1%
2	Submitted to University of Central Lancashire Student Paper	<1%
3	Mohd Zaifulrizal Zainol, Wardiah Mohd Dahalan, Mohd Rohaimi Mohd Dahalan, Mohd Fakhizan Romlie. "Chapter 30 A Review on Contactless Power Transfer Using Matrix Converter Topology for Battery Charging Application", Springer Science and Business Media LLC, 2022 Publication	<1%
4	www.scilit.net Internet Source	<1%
5	Submitted to University of Teesside Student Paper	<1%

6	Submitted to College of Engineering & Technology Bhubaneswar Student Paper		<1%
7	Kishore Naik Mude. "Battery charging method for electric vehicles: From wired to on-road wireless charging", Chinese Journal of Electrical Engineering, 2018 Publication		<1%
8	mek.oszk.hu Internet Source		<1%
9	Adel Razek. "Review of Contactless Energy Transfer Concept Applied to Inductive Power Transfer Systems in Electric Vehicles", Applied Sciences, 2021 Publication		<1%

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Chapter 1: Introduction

Background

Wireless power transfer (WPT) systems for electric vehicles (EVs) have drawn a lot of interest recently as a potential replacement for traditional plug-in charging techniques. With the use of this innovative technology, an EV may receive electrical energy from a power source without the need of physical connections or cables. Instead , power is transmitted through an electromagnetic field between a receiving pad integrated into the EV and a charging pad or infrastructure buried in the ground.

Nikola Tesla first presented the idea of wireless power transmission in the late 19th century when he thought it could be possible to transmit electrical energy wirelessly. However, WPT systems created exclusively for EVs have just been created in recent years. Technology developments and the increased public interest in eco-friendly transport options are partly responsible for this achievement.

By eliminating the physical connection between the EV and the charging infrastructure, wireless power transfer offers several advantages. One of the primary benefits is the convenience it provides to EV owners, as they no longer need to manually connect and disconnect charging cables. Instead, the EV can simply park over a designated charging pad, and the wireless system will initiate the energy transfer automatically.

Moreover, wireless power transfer mitigates concerns related to wear and tear of connectors and cables, which can occur over time with conventional plug-in charging techniques. The absence of physical contact also reduces the risk of electrical shock and eliminates the need for extensive maintenance of charging equipment.

From an aesthetic standpoint, WPT systems contribute to a cleaner and more clutter-free environment. Without the need for visible charging infrastructure or cables, cities and parking areas can maintain a visually appealing landscape while still offering convenient charging options for EVs.

However, it is important to note that wireless power transfer for EVs is still a developing technology, and several challenges need to be addressed. These challenges include the efficiency of power transfer, potential electromagnetic interference, and ensuring compatibility between different EV models and charging the battery .

Literature Review

Wireless power transfer (WPT) systems for electric vehicles (EVs) have seen substantial study and development in recent years, including insights from multiple studies and existing literature. Improving power transfer efficacy by optimising power conversion, gearbox distance, and alignment between charging and receiving pads is critical for WPT systems. Using modern technology such as resonant inductive coupling can be advantageous. Furthermore, improving functionality and interoperability is critical, as is addressing compatibility concerns caused by different EV manufacturers and charging standards. Creating a standardised framework that provides smooth compatibility between EV models and charging infrastructure will speed up adoption and give EV owners with additional wireless charging alternatives.

Aside from the above mentioned problems, guaranteeing security in wireless power transmission systems is critical, necessitating steps to handle electromagnetic interference and prevent electric shock. My suggested method prioritises user safety by utilising sophisticated shielding methods and stringent safety measures. Scalability and deployment of wireless charging infrastructure are other critical factors to consider. The proposed technique focuses on enabling the installation and scalability of wireless charging stations in public parking lots, commercial buildings, and residential locations in order to encourage wider adoption of EVs. Intelligent charge scheduling, load control, and energy optimisation are enabled through integration with smart charging technologies and vehicle-to-grid communication systems, making the charging process even more user-friendly and accommodating for EV owners.

Problem Definition / Objectives of the Work

The wireless power transfer system for electric vehicles (EVs) aims to get over the drawbacks of current charging methods, such tangled wires, safety concerns in wet environments, and the need of physical connections. Its goal is to create a charging solution that is simple, effective, and secure. The system's goals include developing a dependable wireless power transmission system that allows for easy EV charging, meeting the high-power transfer requirements of EV battery charging specifications, ensuring safety through compliance with regulations and precautions against electrical shocks and short circuits, improving charging efficiency to reduce energy losses, and enabling wireless charging in a variety of environmental settings without sacrificing performance or scalability. The assessment parameters include identifying the system's dependability in terms of power supply consistency, resistance to environmental variables, and robustness against failures or malfunctions, as well as measuring charging efficiency, charging time, evaluating safety measures, and determining the system's reliability in terms of power delivery consistency, resistance to environmental factors, and robustness against failures or malfunctions.

Work Plan

Time Period	Workflow
Week 1 And Week 2	Research on the project, Proposal review, and approve project proposal
Week 3	Literature survey, searching and studying of various parameter.
Week 4	Specify the objectives to be attained by the project.
Week 5	Ordered components for the project.
Week 6	Assemble the components and start soldering.
Week 7	Preliminary Progress review of the project and viva-voice examination.
Week 8	We start the software part.
Week 9	We have tabulated various outputs for better performance.
Week 10	Mid-term Progress review of the project and viva-voice examination.
Week 11 and Week 12	We continued our tasting and added some extra features that were given on the evaluation day.
Week 13	Preparation of project reports and final presentation of our project

Organization of the Report

Chapter 2 : A wireless power transfer system for EV charging is designed with a transmitter pad in the ground and a receiving pad in the EV, with resonant inductive coupling used for efficient power transmission without physical connections.

Chapter 3 : The findings and discussion of the wireless power transfer system for EV charging underline the successful implementation of efficient power transfer, improved charging ease, enhanced safety measures, and the likelihood of broad application of wireless charging technology in the EV market.

Chapter 4 : Finally, the wireless power transmission system for electrically powered vehicles has great potential to revolutionize the charging infrastructure, with further advancements to improve efficiency, compatibility, interoperability, and sustainability paving the way for a cleaner and more convenient future of electric vehicle charging.

Chapter 2: Detail Design

Alternative Ideas

1. Capacitive Wireless Automotive Electric Vehicle Charged System

The Wireless Capacitive Automotive Charging System uses capacitive pairing to facilitate wireless power transmission in order to refuel EVs. A charging pad with capacitive plates, a receiving pad built into the EV, and a power converter and control device for efficient energy transmission comprise the system. When the EV is parked over the charging pad, an electric field is formed, and the energy is captured by the receiving pad's capacitive plates. The collected energy is subsequently converted into electrical energy by the power conversion and control unit, which is used to charge the EV's battery. This technology provides a convenient, rapid, and safe charging solution, boosting the broad use of electric vehicles.

2. Wireless Electric Vehicle Charging System with Permanent Magnetic Gear

To wirelessly charge EVs, the Permanent Magnetic Gear Wireless Electric Vehicle Charging system employs a permanent magnetic gear mechanism. The system consists of a charging pad with a main coil, a receiving pad with a secondary coil, and power conversion and control apparatus. The primary coil creates an alternating magnetic field when the EV is parked over the charging pad, and this magnetic coupling causes the secondary coil to generate an alternating current. The permanent magnetic gear assembly facilitates effective power transfer between the coils, enabling the transformation of magnetic energy into electrical energy.

The power conversion and control unit converts the alternating current from the secondary coil into direct current, which is then used to charge the battery.

3. Wireless Inductive Electric automobiles Loading System

The Inductive Wireless Automotive Charging System is an advanced technology that enables the charging of electric vehicles to occur wirelessly. It provides several advantages and benefits, such as ease, efficient power transmission, safety, scalability, resilience, and enhanced look. The method eliminates the need for physical connections, allowing for rapid and easy charging. It improves safety by maximising power transfer efficiency, reducing energy loss, and operating at low voltages. The technology is simple to implement and extend, suited for a variety of situations, and enhances the aesthetics of charging infrastructure. Overall, the inductive wireless charging method is a simple, efficient, and visually beautiful way to charge electric automobiles.

4. Resonant Induction Wireless Electric Vehicle Charging System

Induction by means of Resonant Resonance To charge EVs wirelessly, the Wireless Electric Vehicle Charging System leverages cutting-edge technology. The approach is based on resonant coupling, which means that the charging pad creates an alternating magnetic field that resonates with a receiving pad in the EV, allowing for efficient power transmission. The resonant frequency matching allows the receiving pad's secondary coil to catch and convert the resonant magnetic field back into electrical energy. The charging process is regulated by the power conversion and control unit, which provides optimal power transfer efficiency. The system has several advantages, including great efficiency, ease (no physical connections are required), safety (low voltages, no exposed connectors), and adaptability for different situations.

Design / Comparison Criteria

Design and comparative criteria for wireless electric car charging systems include efficiency, charging rate, orientation tolerance, safety, interoperability, scalability, affordability, dependability, durability, user experience, electromagnetic interference (EMI), and environmental effect. Among the criteria considered are power transfer efficiency, charging speed, alignment flexibility, safety features, compatibility with various vehicles, ability to handle increasing demand, affordability, reliability, component lifespan, user-friendliness, interference prevention, and environmental sustainability. Using these criteria, one may assess and compare the efficacy and acceptability of various wireless charging systems for electric cars.

Selection of Best Concept

When compared to the resonant induction wireless electric vehicle charging system and other charging methods, the inductive wireless electric car charging system outperforms the latter in various ways. Because of their tightly coupled magnetic field, inductive systems have superior efficiency, resulting in lesser power losses during transmission. They also have higher positional tolerance, allowing for successful power transmission even with minor misalignment. Inductive charging systems are more widely available and well-established, with a diverse variety of alternatives and infrastructure easily available. Inductive charging protocol standardisation improves interoperability across different cars and charging infrastructure, in contrast to the lack of standardisation in resonant induction systems. Furthermore, owing to higher frequencies, resonant induction systems create more heat, whereas inductive systems function at lower frequencies, minimising heat generation .While the inductive wireless electric car charging method has advantages, it is also worth noting that resonant induction systems offer certain advantages. Resonant induction can provide more spatial freedom and flexibility in situating the charging pad and the vehicle's receiver, making charging more practical and user-friendly.

Finally, the decision between inductive and resonant induction wireless charging systems is determined by individual requirements, priorities, and the market's level of development and standardisation. However, current considerations favour the inductive wireless electric car charging system because to its superior efficiency, alignment tolerance, commercial availability, standardisation, reduced heat generation, cost-effectiveness, and proven production method.

Electric automobiles have existed on a roadway since the early 1800s. When the internal combustion engine and cheap oil were discovered during the early twentieth century, nevertheless, EVs started to fall out of mainstream production. EVs fell out of fashion due to their extremely limited driving range. The concept of a low-cost, environmentally friendly EV hasn't gone away, however. The short range and high cost of EVs have prevented their widespread adoption. EVs, on the other hand, might displace regular automobiles as a viable choice if Li-ion batteries, quick charging infrastructure, and cheaper manufacturing costs become available. EVs have traditionally been recharged via conductive charging.

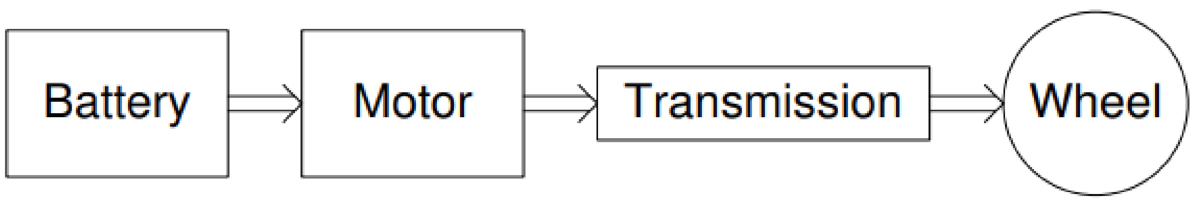

Figure.2.1 EV system a model

Because of environmental concerns and rising oil prices, electric vehicle (EV) technology has improved dramatically in recent years. These cars, which contain electric motors and onboard energy storage devices, have the potential to recover power, enhancing fuel efficiency, and lowering emissions. Due to the complex design philosophy and component technology, EV technologies will require significant development and research before becoming commercially feasible.

Detail Design :

Harmonic insertion rules. To get around these limitations, more complex AC-DC converters incorporating Power Factor Correction (PFC) circuits are used. PFC circuits regulate the rectifier's output voltage and strive for a high power factor by assuring sinusoidal and in-phase grid current. PFC circuits, on the other hand, have downsides such as the requirement for greater output voltage and a restricted capacity to manage bidirectional power flow. For bidirectional power flow or vehicle-to-grid applications, additional circuitry or conversion stages would be necessary. Despite these disadvantages, PFC circuits are essential for providing efficient power transmission and decreasing harmonic distortion.

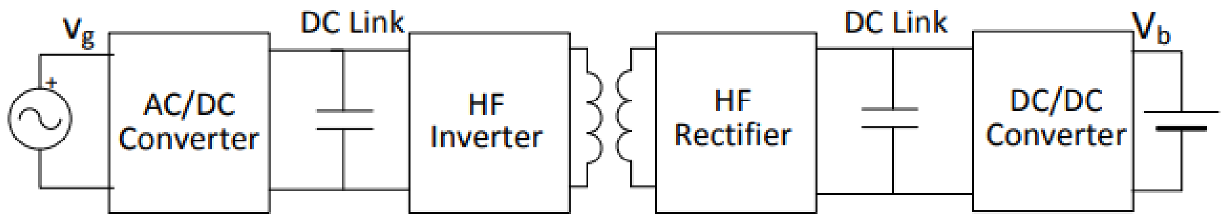

Fig. 2.2. Battery charger concept diagram

- **CBCs as well (Conventional Cell Chargers):**
  - CBCs are classified into two types: unidirectional battery chargers and bidirectional battery chargers.

Charging batteries intended for one-way use

These battery chargers only operate for the purpose of charging the battery. Unidirectional batteries used in electric vehicles (EVs) allow charging but do not generate electricity for the grid. To accomplish their functionality, these chargers frequently employ a filter, which is composed of a diode crossing, and a converter that converts DC to DC. These kind of converters are mostly utilized in a single-phase electrical systems in order to save money and space.

Chargers for bidirectional batteries

A bidirectional charger typically consists of two phases, namely an active grid-dependent reciprocal ac-dc converters that imposes the power factor and a DC to DC converter that aligns the voltage levels. Circuits for these chargers can be constructed with or without isolation. They discharge a sinusoidal current while charging. While discharging, the charger must transmit energy in a periodic sinusoidal manner.

Although bidirectional power flow has been widely researched, its implementation is riddled with difficulties. Bidirectional power flow has to conquer obstacles such as battery loss from frequent cycling, the higher cost of adapters able to deliver reversible power flow, metering problems, and transportation equipment changes. When driving, buyers are likely to desire an energy warranty to ensure the consistency and adequacy of the vehicle's power level. Adoption of bidirectional power flow would necessitate stringent safety procedures. Protection against islanding and other connection issues must also be properly considered.

Modes of charging :

Mode 1: The quickest and least expensive method of charging at home is also the most inefficient. EVs are equipped with connections that enable owners to plug their car into a garage outlet as well as on-board battery chargers. In mode 1, EVs may be charged using a typical 230 V household connection, nonetheless the readily accessible current is restricted to 16 A. Depending on the vehicle, the charging process might take anywhere from 7 to 15 hours to fully recharge the completely depleted battery of a small electric car. In mode 1, standard industrial plugs and sockets are used to connect the EV to the outlet. Since it needed, this pricing method is prohibited in the US.

Mode 2: EVs can use Mode 2 recharging to connect with electrical boxes in driveways or free charging stations that don't have appropriate connectors. It runs on 230 V or 440 V AC current in a one-phase or three separate phases mode and has a maximum operating current of 32 A. This technology allows for simple charging in locations like as malls, restaurants, parks, and offices. By checking connections, monitoring conductor continuity, and managing the charging process, charging boxes, stations, and on-board chargers provide safety and functionality. Mode 2, often known as "opportunity charging," provides a charging duration of 3-5 hours for compact EVs, making it easy and accessible for EV owners in a variety of venues, supporting greater EV adoption.

Mode 3: Mode 3 charging, which operates on multi-phase 440 V AC mains, employs specific connectors and sockets to give up to 63 kW of electricity to the built-board charger for the batteries. In along with the safety precautions incorporated in Mode 2, charging infrastructure and onboard rechargeable batteries coordinate their operations using appropriate protocols. A Mode 3 charge may fully charge a small automobile in less than an hour because to the increased power availability. Larger vehicles, such as electric buses, typically use this charging option, which may be found in public and commercial venues, airports, and transportation corridors.

Mode 4: Mode 4 charging entails the use of a rectifier in the charging station to convert alternating current from the power supply into direct current voltage. The " CHAdeMO" standard created in Japan is the most extensively used mode 4 charging implementation. This standard provides up to 50 kW of power output, allowing a small automobile to be completely charged in less than 30 minutes. Mode 4 charging is ideal for speedy charging circumstances and is widely used in public fast-charging stations.

Magnetic flux density and Coil Inductance :

An inductor is an inactive electrical component that accumulates energy from a field of magnetic attraction. It has two connectors and inductance (L) due to the magnetism formed by a current-carrying wire. When the current varies, the magnetic flux changes, causing a proportional change in voltage. This produces an electromotive force (EMF) that opposes the change in current, resulting in resistance to current variations.

The flux of magnetic energy density, given by the conductor's current, is connected to the field's strength (H) via the magnetic porosity of the medium. The effectiveness of wireless power transmission systems is strongly dependent on the coupling coefficient between coils, which is influenced by their size, shape, and distance. To determine the interaction parameter mathematically, use the Biot-Savart formula, which measures the electromagnetic induction contribution (dB) produced by an electrical current (I) flowing across a minuscule portion of the system at an interval (r) from a particular point (P). Total magnetic induction may be calculated by integrating throughout the whole circuit.

A change in current in one coil produces an EMF in a neighbouring coil, which is known as mutual induction. This factor is critical in the design of wireless power transmission systems.

The magnetic flux concentration across a conductor doesn't seem uniform. Magnetic flux will be greater in the central region of a conductor having one or more circumferential circular portions rather than in surrounding areas. This is because the performed by oneself back EMF is greater towards the conductor's core. As a result, there is less current density at the core comparing to the surface, resulting in increased conductor real resistance.

Circuit Diagram :

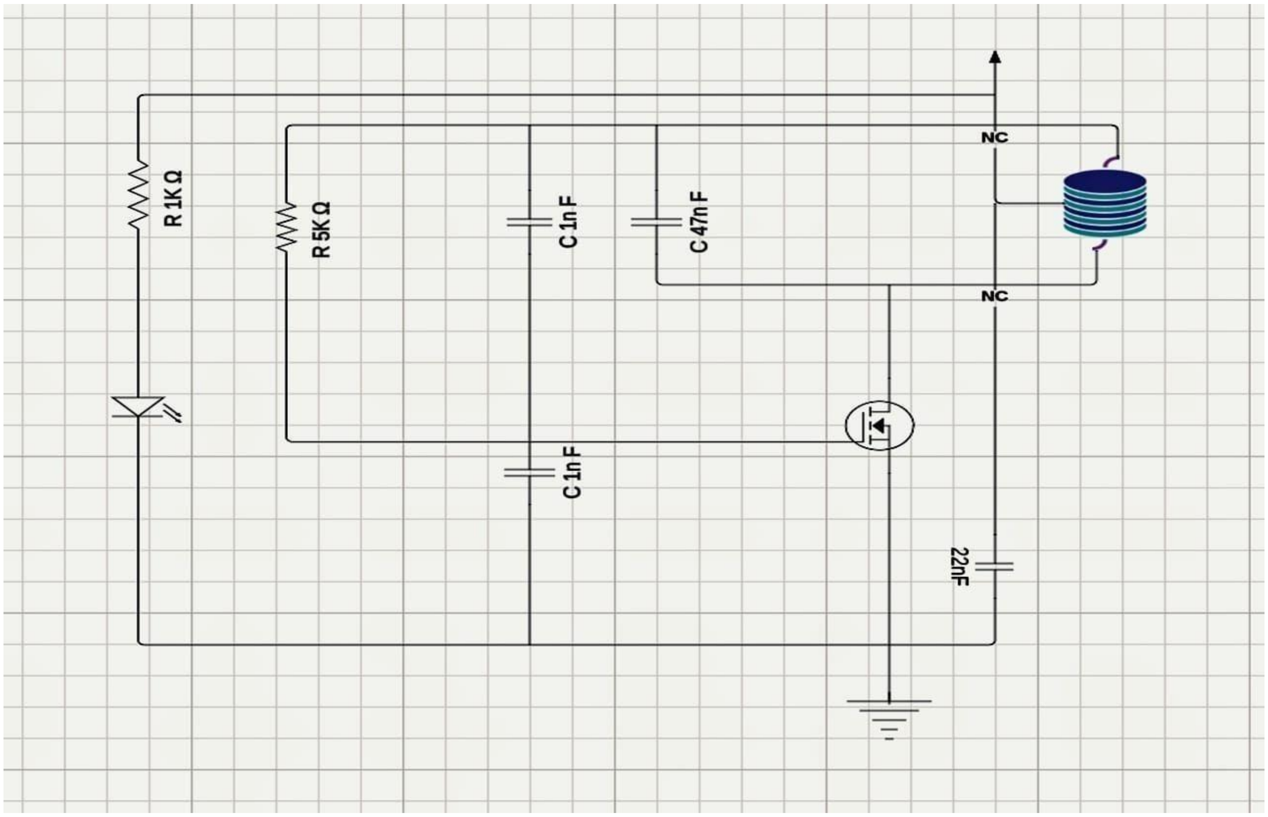

Figure 2.5 Transmitter part of WPT for electrical vehicle battery charging

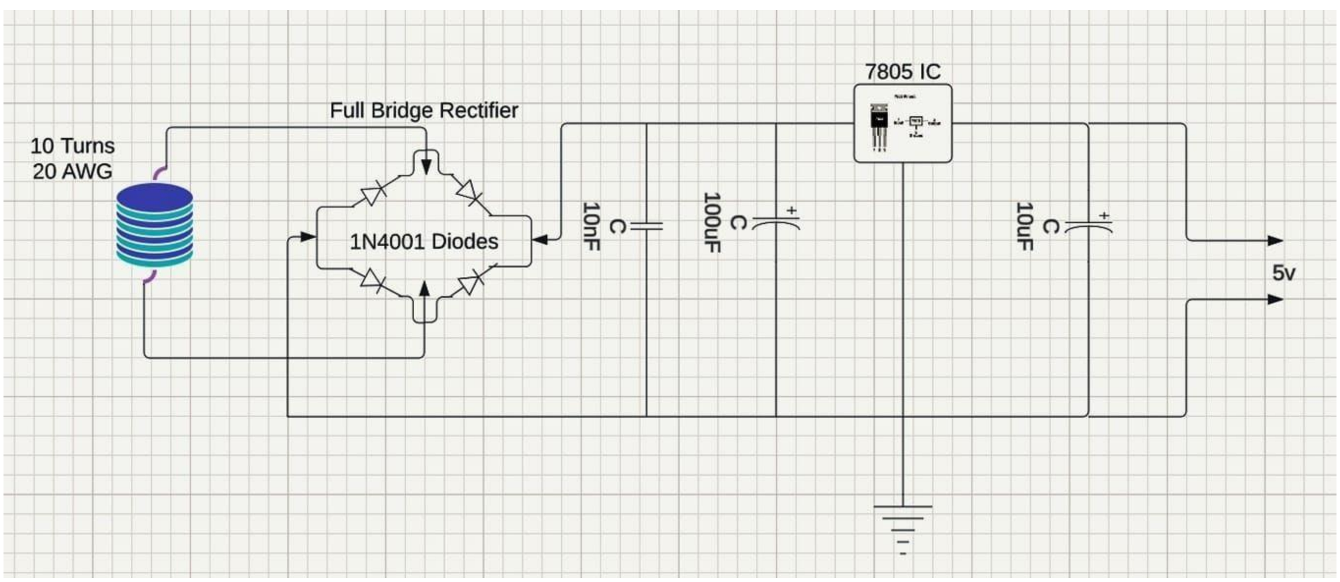

Figure 2.6 Receiver part of WPT for electrical vehicle battery charging

A wireless power transfer system (WPTS) power converter is made up of a front-end power factor correction (PFC) rectifier coupled to an inverter. The transmitter converter is a combination that supplies an alternating voltage to the transmitting equipment. The person receiving the message converting receives power from the device that will receive it and acts as a rectifier to generate the current as well as voltage levels required for cell recharging on the receiver side.

At the power sector level, the WPTS is managed by a single electronic control unit (ECU). However, two ECUs are in charge of the overall operation of the WPTS. The power section is governed by the upper level of regulation, whereas the power converter is governed by the lower level. The upper levels of the two ECUs must interchange. Wireless power transmission necessitates a high-frequency alternating current, Typically oscillates between 10 kHz to 100 kHz, which happens to be significantly higher than the typical 50 Hz frequencies of the electrical supply .An oscillator is coupled with a rectifier and an inverter to create the required frequency. Soft switching approaches (currently employing wide bandgap (WBG) semiconductors) are used to minimise losses, as the inverter's transistors only turn on or off when the current is insignificant. Despite producing a square voltage waveform, the current passing through the inverter becomes sinusoidal due to its connection to a resonant circuit.

The purpose of this chapter is to discuss the power delivery requirements for systems with WPT. To achieve optimal energy transfer efficiency, the covered architectures employ full bridge converters. Conventional hard-switching converters and their resonant transition variations were discovered to be insufficient for meeting the unique needs of WPT applications..

Converter/Inverter for WPT:

On the main side of a wireless power transfer (WPT) system, converters produce high-frequency current. High-frequency current may be produced in a variety of methods, two of which being linear amplifiers and switch mode power converters. Linear amplifiers operate in a linear zone but suffer from significant power loss, restricting its use to low-power applications. Switch mode power converters, on the other hand, provide great efficiency through complete on/off control and are often employed in medium to large WPT systems. Based on the input source, these converters are classified into two types: direct AC-AC converters and DC-AC inverters. Because a direct DC supply is not always accessible, most WPT power converters are two-stage AC-DC-AC converters. current. The first stage includes an AC-DC converter to provide continuous DC power, which necessitates the use of energy storage components to compensate for the discrepancy in instantaneous input and output power. Technologies including synchronous rectifiers, filters, and power factor correction circuits are employed in the AC-DC conversion process. High-frequency track current is produced via a second stage DC-AC converter once stable DC power has been attained.

Solenoid Varieties :

(a) A helix coil is a form of coil that is twisted in a helical or spiral pattern. It is made by winding a wire or conductor in a helical pattern around a central axis, resulting in a three-dimensional spiral structure. The helix coil is distinguished by its regular turn spacing, which results in a consistent pitch or distance between neighbouring loops.

Helix coils are widely utilised in a variety of applications such as antennas, inductors, and solenoids. The helical form has various advantages, including higher inductance and more effective electromagnetic field coupling. The coil's tight wrapping also aids in the creation of compact designs and the effective use of space.

(b) Spiral Coil: As the name implies, a spiral coil is a coil twisted in a spiral pattern. Unlike the helix coil, which has constant spacing between turns, the spiral coil often utilises different lengths between neighbouring loops. This results in a more open and uneven spiral form.

Spiral coils are frequently utilised in situations that need a greater coil size or where its winding process has to be simplified. They are used in a variety of industries, including radio frequency (RF) circuits, wireless power transfer, and electromagnetic devices.

Helix coils and spiral coils each have distinct properties and uses. The decision between them is determined by the application's unique requirements, such as required inductance, size limits, and frequency responsiveness.

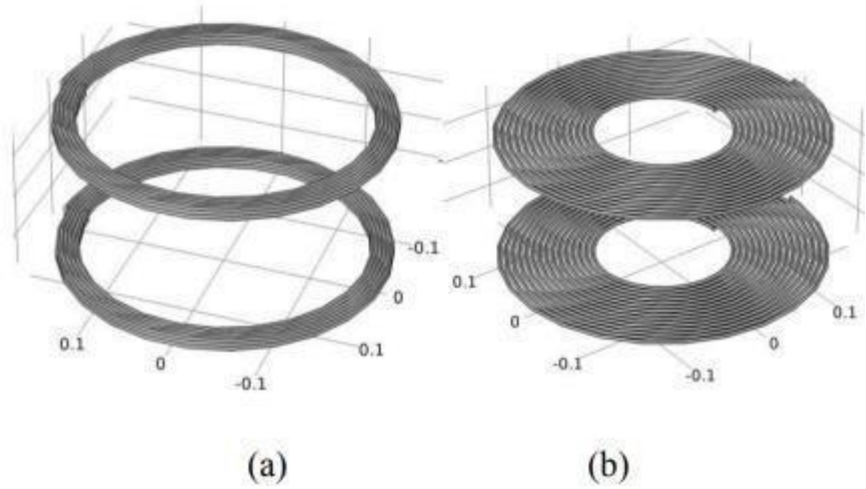

Fig 2.7 Helix Coil and Spiral Coil

Helix coil and sprial coil coil connection configuration analysis :

Several elements are taken into account while analysing the coil coupling configurations of helix coils and spiral coils.

Helix Coil: The constant spacing between turns in a helix coil provides for efficient and reliable coupling between adjacent loops. Because of this homogeneity, the magnetic field distribution and electromagnetic coupling are more predictable. A higher surface area for coupling with external fields is also provided by the helical design.

The coupling of a helix coil may be improved by modifying characteristics such as pitch (distance between turns), number of turns, and coil diameter. Increased pitch can lessen connectivity between adjacent to turns, whereas decreased pitch can promote coupling. The total inductance and the intensity of coupling with external fields are affected by the number of turns.

Spiral Coil: The variable lengths between consecutive loops in a spiral coil can impact the coupling properties. Uneven coupling and magnetic field distribution along the coil may result from the irregular spacing. This can cause changes in inductance and coupling efficiency. A spiral coil's coupling behaviour may be impacted by characteristics like as the distance between loops, the width of the conductor, and the number of turns. These parameters can be tweaked to improve the coupling and electromagnetic performance of the spiral coil.

Overall, the coil coupling arrangement analysis for helix and spiral coils takes into account parameters including spacing uniformity, magnetic field dispersion, inductance, and coupling efficiency. Depending on the application's unique needs and design restrictions .

Overall, the scientific study considers elements such as supply voltage, output power, coil size, and operating frequency to determine the specifications for designing a resonant WPT system suitable for charging the battery pack of the electric city-car in question.

The fully built and working state of your wireless power transfer system is the final form of your WPT project. It consists of a power transmitter that uses coils or resonant circuits to generate an oscillating magnetic field and a power receiver with its own coil or resonant circuit. The magnetic field is created by the transmitter in order to convey electrical energy to the receiver. Using a rectifier circuit, the receiver collects the magnetic field and turns it back into electrical energy. When the receiver comes into contact with the transmitter, an electric current is created in the receiving coil, which is then rectified, filtered, and regulated to provide a consistent DC power output. This direct current power is subsequently sent to the target device. Creating the ultimate form of your WPT project necessitates engineering, design considerations, safety precautions, and optimisation techniques such as resonant coupling to improve power transfer efficiency. For a successful final form, consult resources, undertake thorough study, and collaborate with professionals in wireless power transfer.

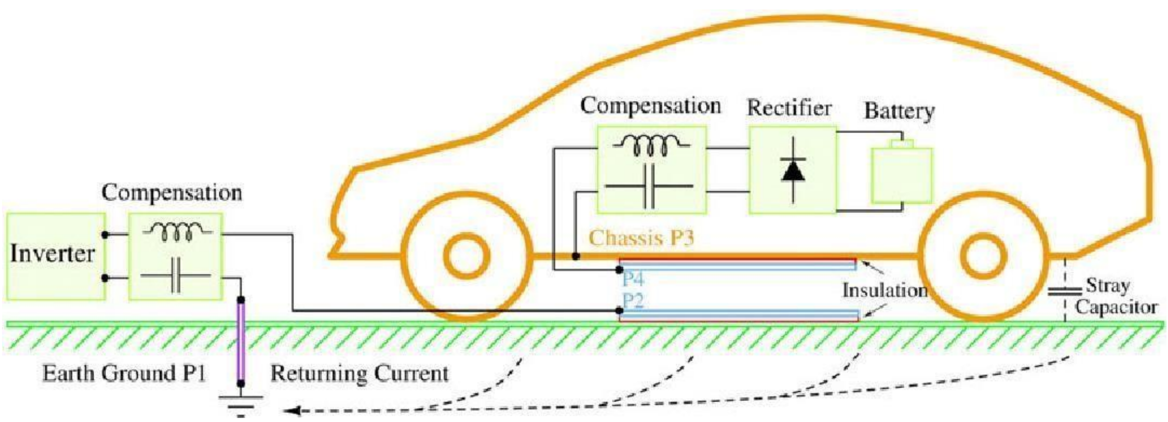

Fig. 2.10 Prototype of WPT

Chapter 3: Results and Discussion

WPT for charging electric vehicles (EVs) has various benefits over standard cable charging techniques. It improves use and convenience by removing the requirement for physical connection and handling of wires and plugs. WPT may be installed in a variety of settings, boosting EV owners' access to charging. It decreases infrastructure requirements by integrating charging pads into existing infrastructure, decreasing upfront expenses and simplifying implementation. WPT systems provide equivalent efficiency to cable charging while including safety precautions and lowering the danger of accidents or connection breakage. It supports sustainability by encouraging the adoption of zero-emission vehicles. WPT systems may also be attractively incorporated into urban environments, maintaining the visual attractiveness of public places.

- **For product design:**

Figure 3.1 depicts the construction of a WPTS. The device's transmitter and receiver are two electrically separated power parts. The receiving device is built inside the electric car and powers the power supply, whilst the transmitting unit is buried in the road surface and gets electricity by the mains.

The latter is represented in Fig. 3.1 by a resistor and makes up the WPTS's load. An adapter for connection and a power converter make up each WPTS component. The coupling device of the transmitter generates a fluctuating field that might be powered by electricity, magnetised or photonic. also referred to as the transmitting device. The above differences may not seem to be accurate in reality since quasi-static field conditions predominate when the oscillations' frequency is relatively low. Depending on the transmitting equipment, The field might be electromagnetic or magnetic. The device that receives the signal (also known as the collecting device) overlaps an alternating field created by the object that transmits and takes up the electrical charge provided by the field.

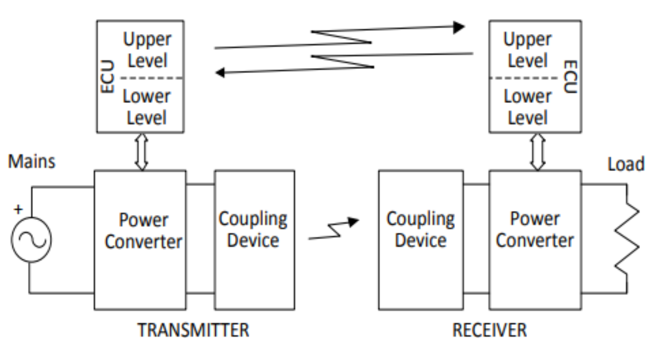

Fig 3.1 WPTS framework

The influence converter, additionally referred to as the point of transmission converter, is made up of a front- end PFC converting stacked by an inverter that gives oscillating power to the transmissioequipment.

The supply converter that's installed in the device that receives power, also referred to as the antenna converter, pulls power from the receiving device and acts as a transformer to provide the appropriate voltage and current levels to recharge the batteries.

The power sector of a WPTS has a single electronic control unit (ECU). Two ECUs are in charge of the WPTS. Two levels of regulation are used: the upper level controls the power section, while the lower level controls the power converter. The two ECUs' top tiers transmit the data necessary for power section control.

With the help of the Wireless Power Transfer (WPT) technology, electrical energy may be sent wirelessly from a power source to a receiver device. It offers convenience and adaptability in a range of applications, including electric vehicles (EVs), consumer electronics, and medical equipment. It employs electromagnetic fields to wirelessly deliver electricity.

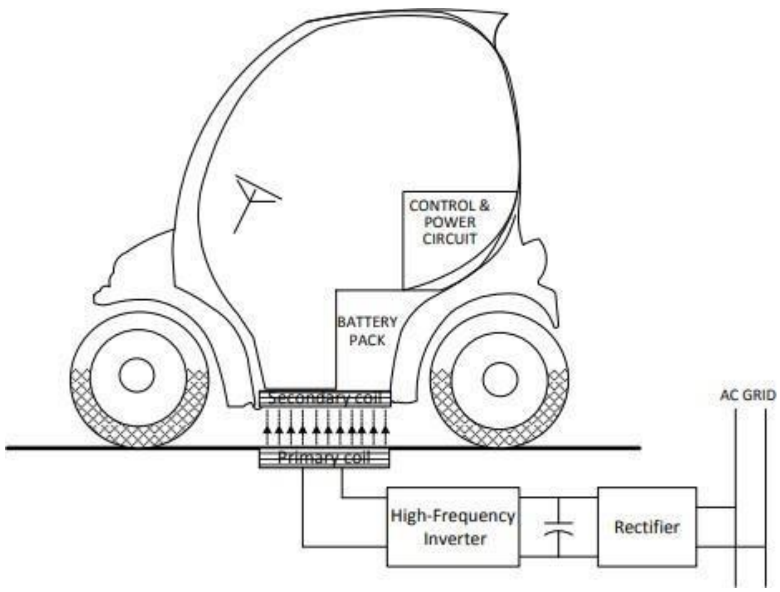

Figure 3.2 WPT Schematics for Charging the Battery Systems of Electric Automobiles

The electromagnetic induction—often referred to as resonant coupling—principle underlies WPT. An alternating current (AC) travels through a transmitter coil to generate a changing magnetic field in electromagnetic induction. This magnetic field produces a voltage in a nearby receiver coil, which may be utilised to power the receiving device. On the other side, resonant coupling employs resonant circuits to carry power across greater distances.

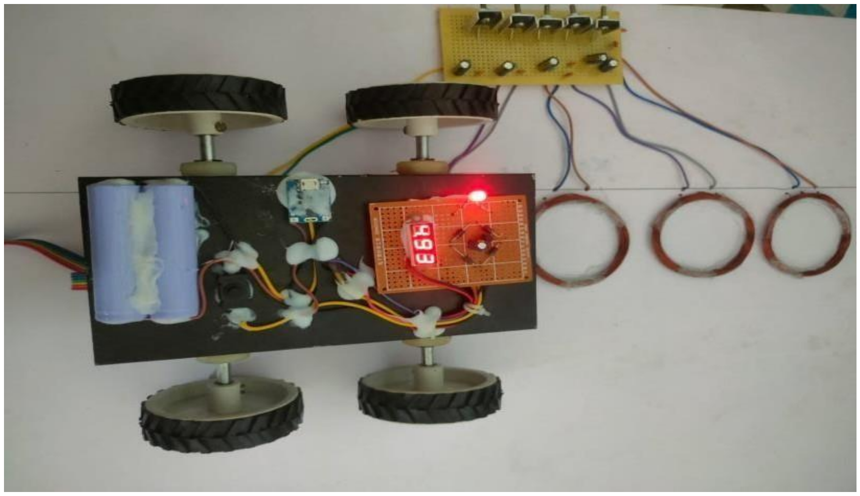

Figure 3.3 Prototype of WPT for electrical vehicle battery charging

- **For process design:**

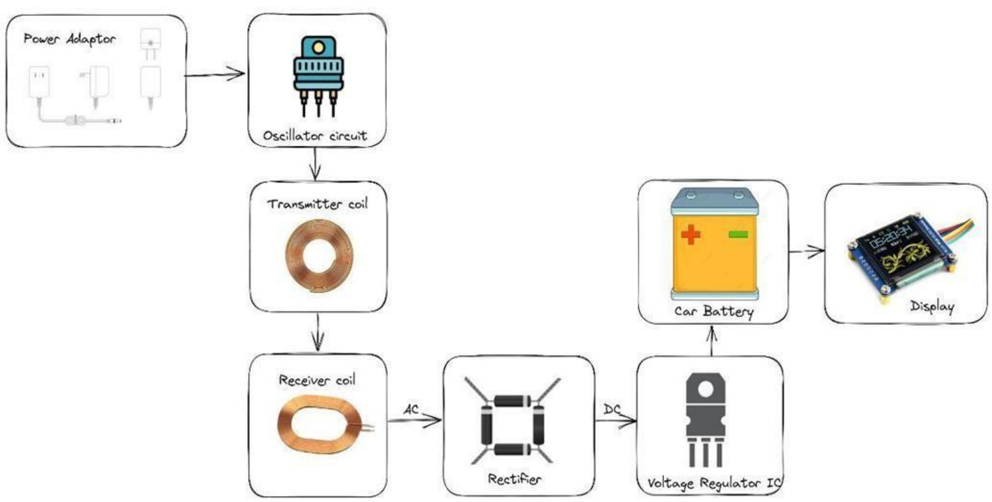

Figure 3.4 Design Scheme of WPT for electrical vehicle battery charging

Fig 3.5 Process of Execution

In a wireless power transfer system, an adapter powers the oscillator circuit, producing an oscillating signal that is sent to the transmitting coil. A magnetic field created by the transmitting coil transports energy wirelessly to the receiving coil. Resonance between the coils maximises the efficiency of power transmission. The receiving coil converts the magnetic field into AC current, which is subsequently changed into stable DC current via an AC to DC converter and a voltage regulator IC. The controlled voltage is monitored by a voltage digital sensor when a battery is charged. Power can be transferred quickly and easily without the need for cords or physical contact thanks to this technology.

WPTS technologies :

Electric energy may be transported in three ways: capacitive, inductive, and radiant, which make use of the coupling qualities of electric, magnetic, and electromagnetic fields. The transmitter device lights up the region around It uses electricity stored in only one measure of space to convey force via capacitive and inductive electrical transfers.

$$W_e = \frac{1}{2}\varepsilon_0 E^2$$
$$W_m = \frac{1}{2}\mu_0 H^2$$

The magnetic field is able to attain an energy density that is around 104 times greater than the electric field because of the permittivity and permeability of empty space as well as the permissible voltages and currents in the coupling devices. Extremely high electromagnetic field levels emerge from the concentration of energy during radiant power transfer along the transmission path.

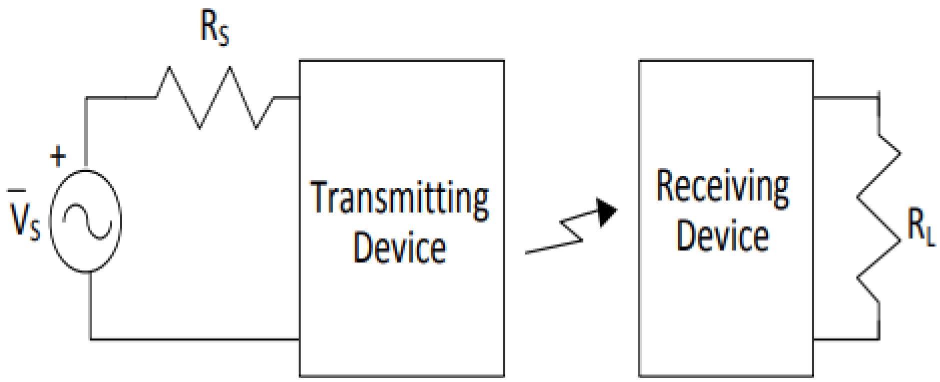

Fig 3.5 WPTS comparable powered circuitry

With the use of two plane capacitors with transmitter and receiver plates, capacitive WPTSs are able to transmit power through metal shields without eddy currents and with little electromagnetic emissions. On the other hand, because of the relatively low energy density between the plates, it can only be used in low-power applications. Because the magnetic field's energy density is higher in free space than it is on Earth, inductive WPTSs employ two coupled coils to transfer greater power. They can operate at higher power levels, but this comes at the cost of coil resistance losses, interference from metallic obstructions, and electromagnetic interference itself. Inductive WPTSs use resonant coupling and inductive coupling topologies for power transmission.

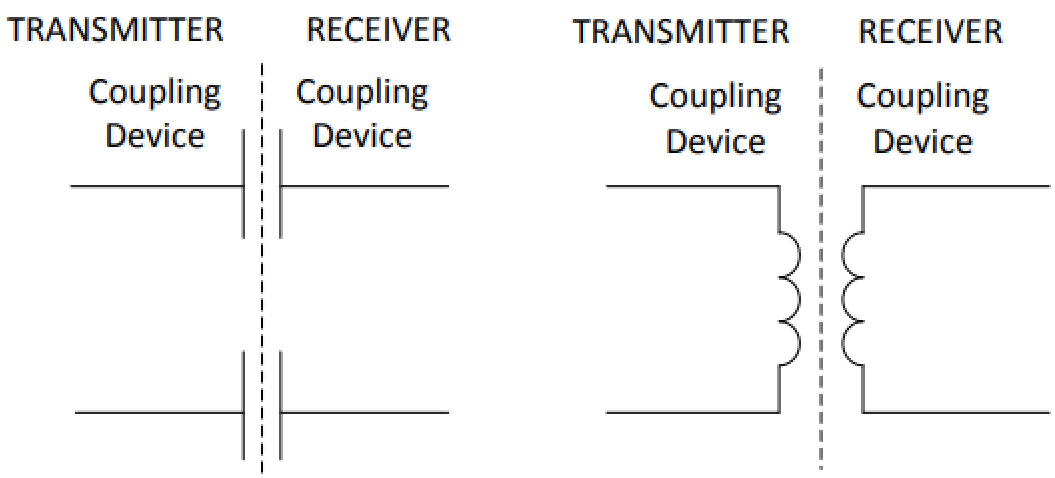

Fig 3.6 Coupling tools for capacitive and resonant WPTS.

Radiant WPTSs :

Radiance WPTSs use directed transmission of electromagnetic waves to transfer power across long distances well beyond the dimensions of the coupling devices. High-frequency waves, such as microwaves and lasers, are employed to do this because they allow for a realistic connecting size of the device in relation with the wavelength [3]. Shorter wavelengths, often in the microwave range, may be used for long-distance power beaming by directing power delivery using radio waves. The microwave energy is transformed back into electricity using a rectenna. A microwave oven magnetron and control electronics make up the microwave source, which has an output power range of 50 W to 300 W at around 3 GHz . The heating element source's signal is hooked up to a coax-to-waveguide adaptor, which is subsequently attached to a waveguide made from filter via coaxial wire.

- **For algorithm/software design:**

The magnetic fields that naturally form when electrical current flows through a wire are used by the inductive wireless power transfer system (WPTS) to transfer power. A wire becomes encircled by a circular magnetic field when an electrical current passes through it. When using inductive WPTS, this phenomena is employed to transmit power wirelessly.

The method works by passing alternating voltage across one part of a coil. An alternating magnetic field is created around the coil by this alternating voltage. As a result, the changing magnetic field generates an alternating current in a second coil, known as the counterpart coil or receiver coil, which is located near to the first coil.

The induced current in the corresponding coil causes a terminal voltage to be generated. This terminal voltage has the same frequency as the beginning coil's applied alternating voltage. The quantity of power delivered wirelessly is determined by the coil parameters, the strength of the magnetic field, and the distance between the coils.

Overall, in Inductive WPTS, the primary coil carrying alternating current generates a magnetic field, which induces alternating current and voltage in the secondary coil, allowing for wireless power transmission.

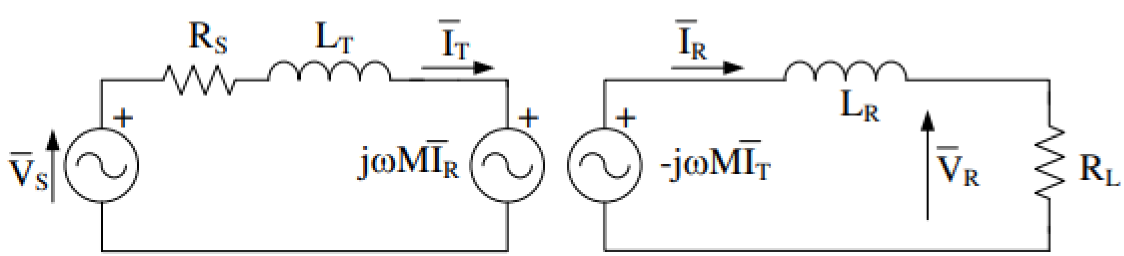

Fig. 3.7. Circuit diagram of inductively deductive WPTSs.

Chapter 4: Conclusions and Future Scope

The purpose of the current project is to build and test a wireless power transfer (WPT) system with transmitter coils incorporated in the roadways for dynamically filling electric vehicles (EVs). A circular receiver coil with a radius of 0.2 m was created for the system, while the transmitter coil was purposefully stretched to 1.6 m, resulting in an asymmetrical shape that minimises the coupling coefficient (k) between the coils. Compensation circuits for both the transmitter and receiver components were rigorously optimised to provide maximum performance under this circumstance.

A test bench experiment was used to determine the system's efficacy, which revealed that it can transmit electric power surpassing 1 kW with an astonishing efficiency of more than 90%. To simulate real-world circumstances, five transmitter circuits were implanted in the surface of a cement asphalt mortar (CAM)-constructed test road. This material choice guarantees that the transmitter coils are not damaged by high temperatures or pressures, ensuring their durability and performance.

The receiver circuitry was installed on a small two-seater electric vehicle, and a successful demonstration demonstrated the flawless receiving of electric power from road infrastructure. This demonstrates the utility and viability of the intended WPT system for charging EVs on the go.

To summarise, this research built and tested a WPT system with embedded transmitter coils in road infrastructure. The system achieved outstanding power transfer efficiency through careful design decisions, optimisation of compensating circuits, and material selection. The test on an EV verified its capacity to wirelessly accept electric power from the road, demonstrating its potential for real-world use.

In Future , There are plans to investigate electromagnetic interference (EMI) arising from the transmitter coils in the future. It is critical to reduce EMI further in order to increase transferrable power during system operation.

It is worth noting that the structure described in this study was created and optimised just for unidirectional electric power transmission, particularly from the road to the car. A comprehensive study is also planned for future research to allow the concept of transportation to the grid (V2G), which is necessary for reversible power transmission across systems and on-board batteries.

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Appendices

Appendix A: Socio-Economic Issues associated with the Project

Detailed Cost Analysis

Economic Issues and Cost Analysis

- Cost and Affordability: Installing and maintaining a wireless charging system can be expensive. This cost might be passed on to EV owners, thereby raising the overall cost of EV adoption. To avoid establishing an economic barrier to EV ownership, it is critical to provide affordability and accessibility for all socioeconomic categories.
- Infrastructure Development: Building a large-scale wireless charging network necessitates considerable infrastructure development. Installation of charging pads or coils in various locations such as parking lots, residential areas, and public spaces is required. Infrastructure expansion funding and coordination can be difficult, especially in economically deprived areas where resources are limited.
- Energy Efficiency and Environmental effect: While wireless power transfer systems are convenient, their energy efficiency and environmental effect may raise issues. Wireless charging can result in energy losses during the power transmission procedure, making it inefficient compared to standard cable charging. It is critical for long-term adoption that wireless charging solutions have a low total energy usage and environmental imprint.
- Grid Capacity and Load Management: The widespread adoption of EVs, together with wireless charging, can put current power systems under pressure. High power demands during concurrent charging sessions might overload local grids, perhaps resulting in blackouts or the need for costly grid modifications. To properly handle growing electricity needs, proper load management tactics and grid infrastructure enhancements are required.

Bill of Materials

#	Component	Specification	Unit Cost	Quantity	Total
1.	Transistor - BD139	Transistor Type – NPN.	20	5	100
2.	DIODE	1N5401(100v,3A)	5	4	20
3.	Resistor	330Ω	1	5	5
4.	Capacitor	0.3-1,2200,1(µF)	10,30,20	5	100
5.	7805 IC	Input Vol : (7v25v) OutPut Vol :(5v)	15	1	15

6.	Volatge Sensor	3.3 v -5 v	120	1	120
7.	LCD Display	16 X 2 (4.7v – 5.3v)	110	1	110
8.	Lithium-Ion Rechargeable Cell	18650 3.7V 1200mAh Lithium-Ion	55	2	110
9.	Insulated Copper Wires	20AWG	10	5m	50
10.	LED	Red LED 10mm	5	1	5
11.	Switches	Push Down	5	1	5
12.	Car Chesis	INVENTO 4 Wheel Car Kit Metal Chassis 260x130x45mm	1000	1	1000
13.	DC Motor	30 RPM DC Motor + 70x40 mm	150	2	300
14.	Wheel	Robot Car wheel	25	4	100
				Grand Total	2040/-

Safety issues

The use of wireless power transfer devices to charge electric cars (EVs) creates several safety concerns. Here are some of the most serious safety concerns about wireless charging:

Wireless charging systems are subject to a number of factors and possible obstacles. Electric shock dangers can occur if the system is not developed, installed, and maintained appropriately, necessitating the use of safety measures such as insulation, grounding, and fault detection systems. Thermal management is critical for avoiding overheating and fire hazards, necessitating the incorporation of temperature sensors, thermal insulation, and heat dissipation devices. To minimise interference with neighbouring electronic equipment, careful electromagnetic compatibility (EMC) design and testing are essential. Furthermore, compliance with safety and environmental requirements is required for the correct recycling and disposal of system components in order to prevent environmental pollution.

Global Impact

Implementing a wireless power transfer system for charging electric vehicles (EVs) can have a huge worldwide influence in numerous areas:

Wireless charging methods offer a number of issues and benefits. They contribute to environmental sustainability by lowering greenhouse gas emissions and encouraging the usage of electric cars, so assisting climate change initiatives. While wireless charging is less efficient than cable charging, it optimises energy consumption, minimises losses, and allows for smart charging that is synchronised with renewable energy generation. As EV usage grows throughout the world, wireless charging can have an influence on energy demand and system resilience, demanding infrastructure changes, load control technologies, and the integration of energy storage and smart grid solutions. Furthermore, wireless charging has the potential to increase energy and transportation access by allowing charging in distant places and regions with inadequate infrastructure, bridging transportation gaps, and fostering inclusion.

The worldwide effect of a wireless power transmission system for EV charging might include environmental, economic, technological, and social considerations. It has the ability to contribute to long-term development objectives, revolutionise transport networks, and drive energy innovation, while also needing collaborative efforts and careful planning to solve associated issues.

Lifelong Learning :

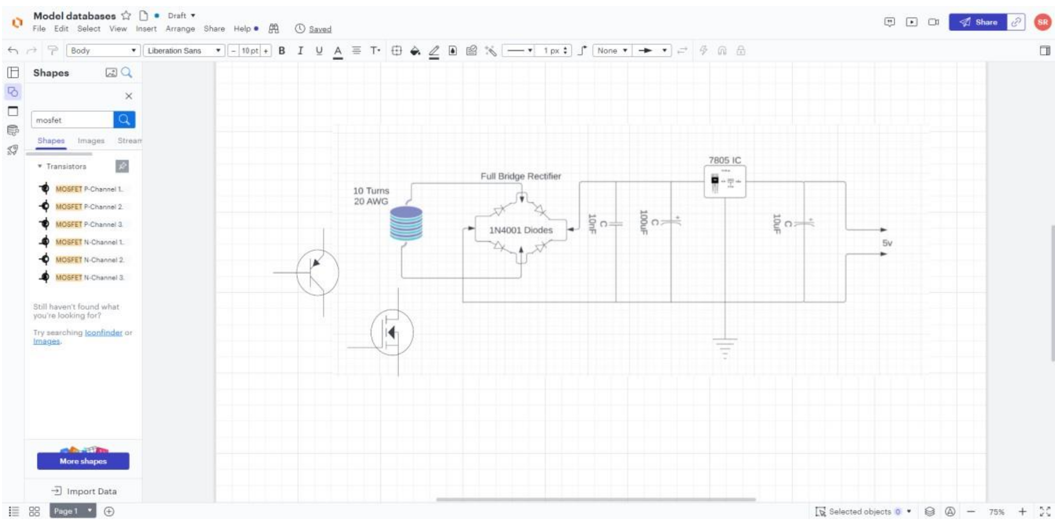
Using a wireless power transfer system for EV charging can teach you important life lessons:

- Problem Solving and Innovation: Using creative ideas to overcome technical and regulatory constraints.
- Collaboration and teamwork: Collaborating with a variety of stakeholders to achieve project objectives.
- Environmental Awareness and Sustainable Design: Emphasis on energy efficiency and environmental effect reduction.
- Adaptability and Flexibility: The ability to adapt to changing wireless charging technology and standards.
- Maintaining industry trends and developments via continuous improvement and lifelong learning.
- Persistence and Resilience: Improving tenacity and problem-solving abilities in the face of adversity.

Appendix B: Engineering Tools and Standards used in the Project

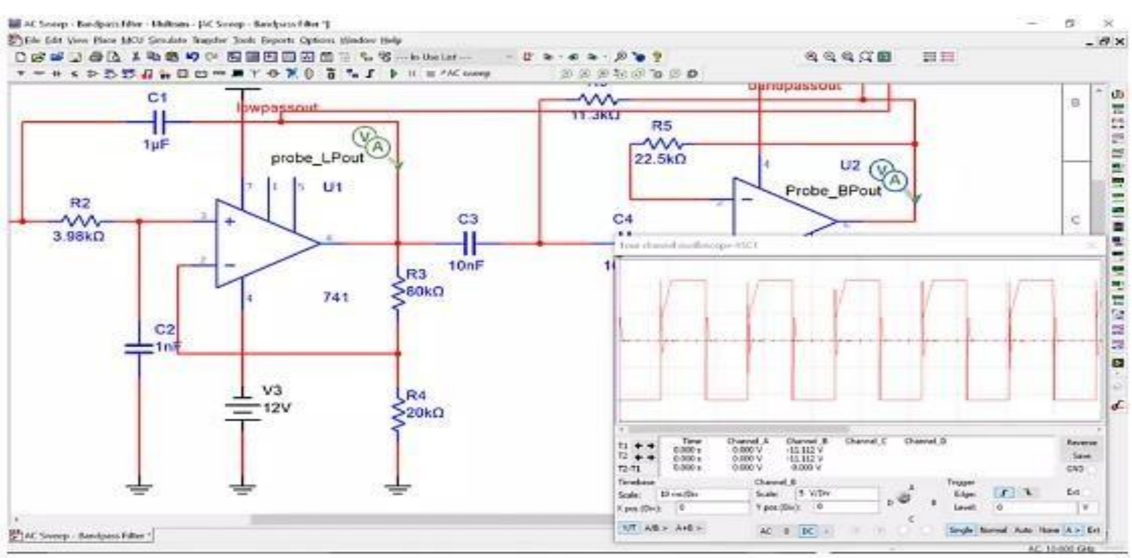
➢ **<u>Lucid Chart :</u>**

Lucidchart is an online circuit design programmer that allows you to create graphical and schematic circuit designs. Make use of our circuit symbols and simple editor.



➢ **<u>Multisim :</u>**

Multisim is industry-standard SPICE simulation and circuit design software used in teaching and research for analogue, digital, and power electronics.



Appendix C: Problems, faults, bugs, challenges

Problems

- Wireless power transfer for electric car charging has issues such as a small working area, higher heat generation compared to traditional techniques, and copper loss owing to the usage of copper cable for power transmission. The restricted working area limits flexibility and convenience, while heat generation has an impact on efficiency and lifetime, and copper loss diminishes total system efficiency. Ongoing research, however, intends to overcome these obstacles and increase the efficiency, safety, and efficacy of wireless power transfer systems for electric car charging.

Faults

- The lack of heat reduces transistor consumption, resulting in transistor overheating. To alleviate this issue, heat shrink tubing or a heat sink should be used to disperse heat from the transistor. This will aid in the maintenance of an ideal operating temperature and the prevention of overheating.

Bugs

- Not Applicable

Challenges

- These include assuring adequate transmitter and receiver location and alignment, controlling energy flow for various vehicle types, resolving cost concerns, eliminating power loss due to copper connections, and broadening the restricted range of wireless power transfer systems. Thorough research, inventive design, and collaboration with specialists are required to solve these problems. By overcoming these challenges, a strong and efficient wireless power transfer system for charging electric vehicles may be built, contributing to the growth of sustainable transportation.

Appendix D:Teamwork and Project Management

Summary of team work

Attributes

1	Attends group meetings regularly and arrives on time.
2	Contributes meaningfully to group discussions.
3	Completes group assignments on time.
4	Prepares work in a quality manner.
5	Demonstrates a cooperative and supportive attitude.
6	Contributes significantly to the success of the project.

Score

1=strongly disagree; **2**=disagree; **3**=agree; **4**=strongly agree

Student 1: _Shubhani Arunashree________________________________

Student 2: _Snehashisa Subudhi Ratna ________________________________

	Evaluated by Student 2	
Student 1	Attributes	
	1	4
	2	4
	3	3
	4	4
	5	3
	6	4
	Grand Total	4

	Evaluated by Student 1	
Student 2	Attributes	
	1	4
	2	3
	3	3
	4	4
	5	4
	6	4
	Grand Total	4

Summary of Project Management

#	Component	Individual Contributions in %		
		Shubhani Arunashree	**Snehashisa subudhhiRatna**	**100**
1.	Planning	50%	50%	100
2.	Background Research and Analysis	70%	30%	100
3.	Hardware design	30%	70%	100
4.	Software design	50%	50%	100
5.	Testing	50%	50%	100
6.	Final Assembling	50%	50%	100
7.	Project report writing	40%	60%	100
8.	Presentation	50%	50%	100
9.	Logistics	60%	40%	100
10.	**Total Score**	450	450	900
11.	**Percentage**	50%	50%	100%

Signature of Student 1

Signature of Student 2

Appendix F: Reflection on the Design Process

What you learned as a team in your own words.

- We gained knowledge about the value of teamwork, collaboration, transparent communication, careful planning, technical know-how, adaptability, and problem-solving throughout the course of our project. We got greater results by cooperating and playing to each other's abilities. We were able to maintain focus and track progress efficiently because of our careful preparation and organisation. We deepened our expertise of wireless power transfer technologies and the charging of electric vehicles, broadening our technological acumen. It was essential to adapt and discover different strategies to overcome obstacles. Our abilities in these areas were developed through learning about project management, time management, and problem-solving. Overall, these lessons help us improve personally and professionally and will be useful to us in the projects we work on in the future.

What you learned as a member.

- As a team member, I have learned more about electric vehicle charging and wireless power transmission systems. In order to emphasise the value of teamwork and open communication, I have developed my communication and teamwork abilities. I've learned how important it is to plan everything out thoroughly so that I can create goals that are clear and track my progress efficiently. I've improved my ability to be flexible and adaptable, coming up with original answers for unexpected problems. I've also improved my time management, project management, and problem- solving abilities, which help me organise my workload and deal with problems effectively. These lessons will help me develop both personally and professionally.

What are the strengths and weaknesses of your design process.

- Our design method has its advantages in that it is well-researched, collaborative, iterative, and detail-oriented. We carried out in-depth research, promoted teamwork, iterated our design until it was perfect, and paid great attention to crucial aspects. Weaknesses that we encountered included time restraints, a lack of resources, and most likely lack of understanding in some areas. We made the most of the resources at our disposal, looked for outside assistance, and made use of team members' strengths to solve these weaknesses.

Appendix G: Project Proposal Form

Project Proposal Form for Senior Design Project (EET4101)

Particulars of Student (s)[Maximum 3 students per project]:

Group No.: 03			
S. No.	**Registration No.**	**Name**	**Section**
1	1941016019	SHUBHANI ARUNASHREE	B
2	1941016051	SNEHASHISA SUBUDHI RATNA	B

Particulars of Supervisor(s)

S. No.	**Name**	**Designation**	**Dept.**
1	SABITA MALI	ASSOCIATE PROF.	ECE

Project Title (in CAPITAL letters):

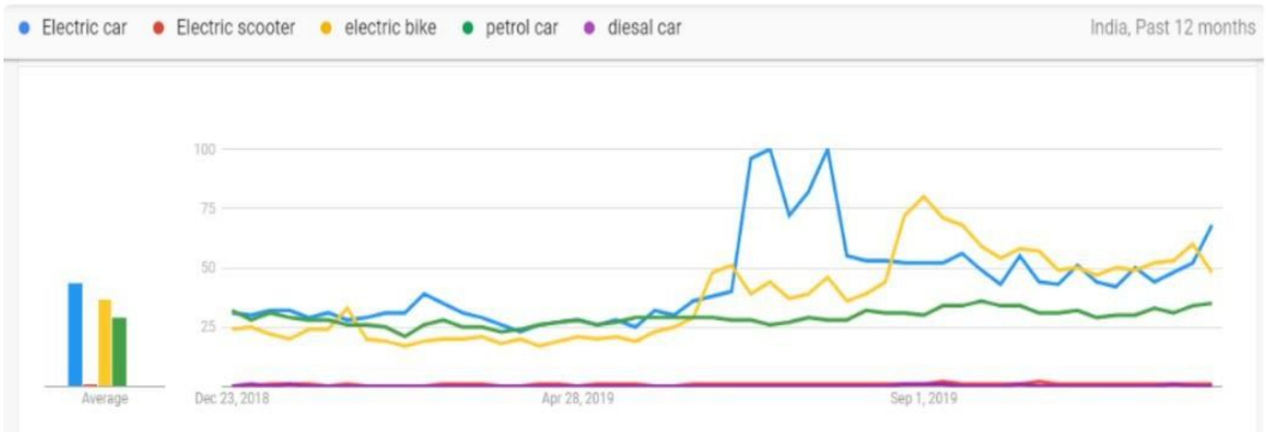
- WIRELESS POWER TRANSFER SYSTEM FOR CHARGING OF ELECTRIC VEHICLES

Details of the Proposed Project (max 300 words)

- **Background**
  - ➢ To reduce the pollutant emissions caused by nonrenewable fossil fueled vehicles and to provide the alternative to costly fuel for transportation the world has shifted to Electrified mobility. But for Electric Vehicles(EV), charging process and travelling range has become a major issue which is affecting it's adoption over petrol or diesel vehicles .
- **Motivation**
  - ➢ The advantage of this idea is that entire people will be out from facing travelling distance problem when opting an EV. Also Carbon monoxide emission vehicles (petrol vehicles) will be entirely

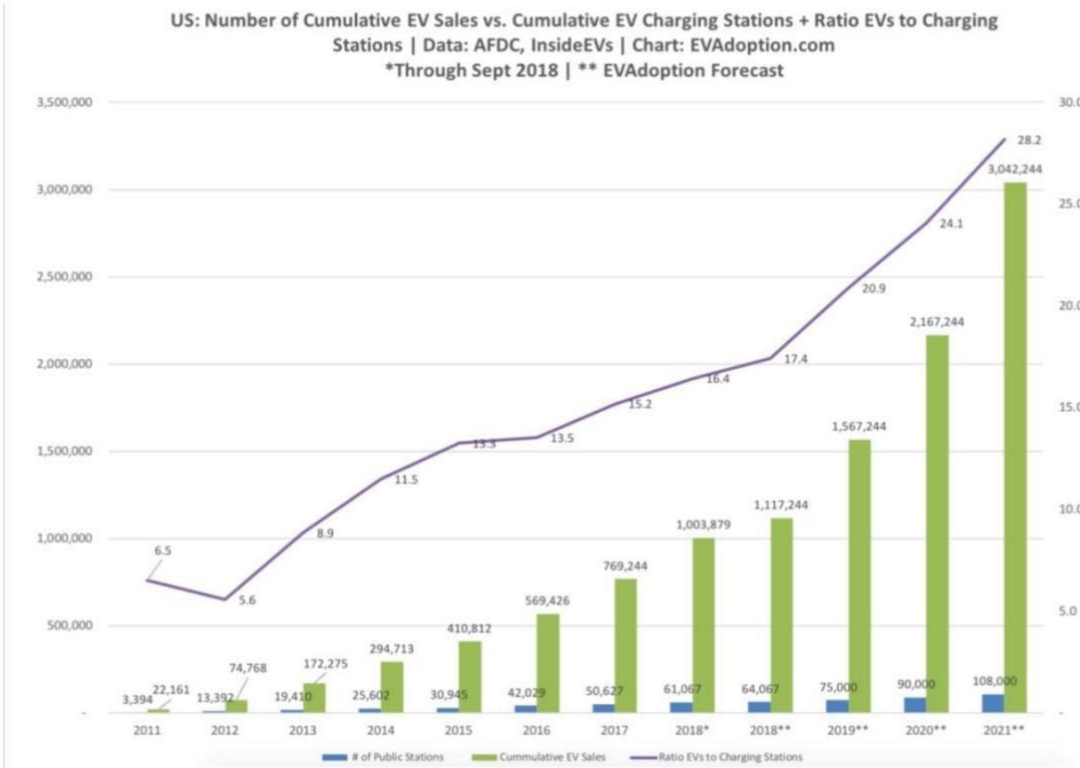
gone from here and with that the world will be safe from not getting polluted from sound pollution, carbon monoxide pollution, fuel expense and also we can get clean cities and places. The daily travel expenses of individuals can be less with using electric vehicles.

- According to the latest survey by Economic Times, Electric Vehicles are going to hit the market completely by 2030 in India.



- In 2030 the governments are going to ban the internal combustion(IC) engines and none of the customers are going to choose the IC engines after a time like 2030 and EVs are getting into the future as soon as possible.

- Electric Vehicles(EV) is fully dependent on plug in mode of charging and can only give a range up to 400kms which is not enough for a long journey or trip. Also static mode of charging is very time consuming.



- ➢ The above graph is the comparison between the number of charging stations and the numbers of EVs sale which shows that there is a drastic difference between them and that is a massive issue for people.
- ➢ The above graph is the comparison between the number of charging stations and the numbers of EVs sale which shows that there is a drastic difference between them and that is a massive issue for people.

- **Objectives**

  - ➢ A dynamic mode of charging which uses induced coupling for power transfer.
  - ➢ To overcome the time consumption which are wasted in EV charging station.
  - ➢ To make the charging process wireless and automatic.

- **Components Required**

  - ➢ Hardware
  - ➢ Battery
  - ➢ Voltage Sensor

- LCD Display
- Transformer
- Regulator Circuitry
- Transmitter and Receiver coils
- Vehicle Body
- Wheels
- Switches
- LED's
- PCB Board
- Resistors
- Capacitors
- Transistors
- Cables and Connectors

Pieces of Software

- Multisim
- Lucid Chart

Tentative Work Plan

Time Period	Workflow
2/01/2023	Research on projects
11/01/2023	Discussed project topics
15/01/2023	Develop project proposal
16/01/2023-20/01/2023	Proposal review and viva-voce examination
21/01/2023	Approve project proposal
25/01/2023	Literature survey
10/02/2023	Specify the objectives to be attained
15/02/2023	Data collection
17/02/2023	Analysing and collection of required documents
20/02/2023	Designing of circuit diagram considering various parameters
27/02/2023-02/03/2023	Progress review of the project and viva-voce examination
8/03/2023	Implementation of circuit

15/03/2023	Testing and analysing of the results
25/03/2023	Improvisation of circuit if needed
1/04/2023	Preparation for project report and presentation
24/04/2023-27/04/2023	Project presentation and open house viva-voce examination

Declaration from the Students:

We shall arrange to submit reports about the progress of the work and final report as per the format provided by the Department of ECE on completion of the project.

Date:
Place: SOA , Bhubaneswar

[Signature of the First Student][Signature of the Second Student] [Signature of the Third Student]
[Name of the First Student] [Name of the Second Student] [Name of the Third Student]

Recommendation from the Supervisor(s):

I/we **ShubhaniArunashree, SnehashisaSubudhiRatn** from the Department of **Electronics and Communication Engineering** recommend the above project, which is to be carried out under my/our supervision.

Date:
Place: SOA , Bhubaneswar [**Signature(s) of Supervisor(s)]**

Appendix H: Weekly ProgressReports from Supervisors

Progress Report #____ for Senior Design Project (EET4101)

Meeting No: **Date**:

Venue:

Group No.:			
Sl. No.	**Registration No.**	**Student Name**	**Attendance**
1.	1941016019	Shubhani Arunashree	
2.	1941016051	Snehashisa Subudhi Ratna	

Topic(s) of Discussion:

WIRELESS POWER TRANSFER FOR CHARGING OF ELECTRIC VEHICLES .

Remarks from Supervisor(s):

During the course of the Senior Design Project, Shubhani Arunashree and Snehashisa Subudhiratna has shown remarkable dedication, diligence, and problem-solving skills. Their ability to conduct thorough research, design a comprehensive plan, and successfully implement the prototype is commendable. They have demonstrated excellent teamwork and communication skills throughout the project. I have full confidence in their ability to complete the remaining tasks and deliver a high-quality final product.

[Signature(s) of Supervisor(s) with Date]