WIRELESS CHARGING SYSTEM FOR ELECTRICAL VEHICLE USING TWO RECEIVER COILS

Dr.G.Venkataswarulu.M.Tech,Ph.D[#1], P.Monica Grace[*2], Sk.Saniya[*3], K.Harshitha[*4],S.HanishkaRavithra[*5]

[1] Professor and HOD, [2,3,4&5] Students

Department of EEE, Narayana Engineering College Nellore

[1]*hodeee@necn.ac.in*

[2]*monica.grace2004@gmail.com*

[3]*sksaniya2602@gmail.com*

[4]*kancharlaharshitha105@gmail.com*

[5]*hanishkaravithra@gmail.com*

Abstract

This paper discusses dynamic wireless power transfer as a realistic solution to the range anxiety issue of electric cars and reducing the cost of battery packs. Compared to traditional static wireless charging, dynamic charging transfers power when the vehicle is in motion, but its analysis involves numerous parameters, making it a complicated task. This research puts forward a new concept to advance dynamic wireless charging through the introduction of extra receiver coils, with optimisation in power transfer efficiency. An elaborate mathematical model is established to estimate energy transfer from source to vehicle. The designed system is confirmed by MATLAB/SIMU LINK simulations, reflecting enhanced charging efficiency and performance under real-time vehicle movement conditions.

Keywords: Coils, Electric vehicles, Mutual inductance, Wireless charging systems.

I. INTRODUCTION

Growing limitations in fossil fuels and increasing environmental issues have necessitated a high demand for alternative energy solutions. The transportation sector, which burns almost half the world's output of oil, is a leading cause of carbon emissions. With this, EV's have risen as a solution. Nonetheless, inefficiencies such as storage efficiency of energy, production expenses being too high, and charging capacities remain obstacles towards mass use.

Emerging technology in electrical energy storage has enhanced mass energy density and power capacity for electric vehicle applications. Nonetheless, there are still very high costs. Scientists are continuously working on improved storage solutions, refining charging modes, and enhancing system reliability in a bid to lower overall vehicle prices. Good control of the electric motor and battery recharge system has been the key area of emphasis, targeting reduced energy loss and increased performance.

Wireless charging technologies have drawn interest for increasing EV autonomy and efficiency. Multiple methods, such as inductive power transfer and capacitive wireless power transfer, have been considered. Nonetheless, current models largely account for one receiver coil only, restricting charging efficiency and vehicle performance as a whole.

This paper presents a new method using two receiver coils to improve wireless power transmission. An extensive mathematical model is presented that considers important factors like coil resistance, inductance, pitch angle, and receiver displacement velocity. Experimental tests show enhanced efficiency and independence, particularly under dynamic conditions. The results provide insightful information on optimizing wireless charging for EV's toward more sustainable and practical e-transportation systems.

II. LITERATURE SURVEY

Current studies have centered on maximizing renewable energy resources and advancing electric vehicle (EV) infrastructure to achieve efficiency and sustainability. Photovoltaic solar generator (PVSG) studies highlight the necessity of working at

optimal efficiency. Different tracking algorithms for maximum power point tracking (MPPT) have been created, with newer methods surpassing traditional methods in solar-powered systems.
To meet the requirement of quick-charging stations, scientists have recommended optimised planning models taking into account user convenience, economic viability, and environmental sustainability. By applying sophisticated optimisation methods, these models enhance station usage and reduce power grid disruptions.

Technologies for wireless charging of EV's have been intensively researched and studied with reference to coil alignment, energy efficiency in transfer, and influence from external factors. Research on mutual inductance and evolution of magnetic flux has enabled development to improve wireless charging techniques, achieving stable and effective power delivery.

To improve micro grid efficiency, new optimisation methods have been used to control power generation from various sources, such as photovoltaics and combined heat power systems. The techniques are more efficient than conventional methods in economic load dispatch, providing cost-effective energy distribution.

Load frequency control (LFC) has been developed to sophistication in contemporary power grids using sophisticated optimisation methodologies, incorporating renewable energy and energy storage facilities. These advancements provide greater stability and adaptability to the power system to support increasing demands for renewable energy integration.

III. OBJECTIVES OF WORK

A two-receiver coil wireless charging system prototype is developed to maximize power transfer efficiency and minimize electric vehicle charging time. The system is made compatible with different EV models by standardizing coil positions and power demand. It seamlessly integrates with current EV hardware and takes scalability into account for commercial manufacturing. With the use of dual coils, charging is made more efficient with reduced energy loss and enhanced overall performance. The system goes through rigorous testing for the assessment of charging speed, energy efficiency, and dependability, ensuring the practicality of the system for mass application in the EV market.

IV. WIRELESS POWER TRANSFER

Wireless power transfer (WPT) allows the wireless delivery of electrical energy through electromagnetic fields without physical connections. The idea originated with Nikola Tesla's experiments in the 19th century, but major developments took place in the 21st century, especially after MIT scientists showed magnetic resonance coupling in 2006. This paved the way for consumer products, such as Qi wireless charging for mobile phones. WPT improves convenience, mobility, and safety by eliminating cables and exposed electrical contacts. It is applied extensively in consumer electronics, medical devices, and electric vehicle charging. The technology operates by transmitting an alternating current (AC) through a transmitting coil, generating an electromagnetic field that induces current in a receiving coil. The energy is rectified into direct current (DC) for use in devices. Efficiency is a function of coil alignment, distance, and frequency. Developing advancements only serve to enhance the performance of WPT and make it an essential technology for application in the future.

Disadvantages of Wireless Power Transfer (WPT) :

1. Limited Range– Devices have to be kept near the charging source, limiting mobility.

2. Interference– Wireless devices or metal objects can interfere with charging or destroy devices.

3. Inefficiency Issues – Energy dissipation over greater distances can result in inefficiency and environmental costs.

4. High Cost – Pricier than conventional wired charging, hampering mass use.

5. Heat Generation– Charging can generate excess heat, which can damage devices.

6. Regulatory Challenges – Subject to regulation in some areas, hampering implementation and cost.

V. ELECTRIC VEHICLES

Electric cars (EV's) originated in 1832, through Robert Anderson's creation. Thomas Parker constructed a functional EV with lead-acid batteries by 1884. EV's prospered until gas-powered automobiles became ubiquitous. Increased interest re-emerged during the 1970s oil crisis and the 2000s battery technology. Presently, EV's are the linchpin of sustainable transport globally.

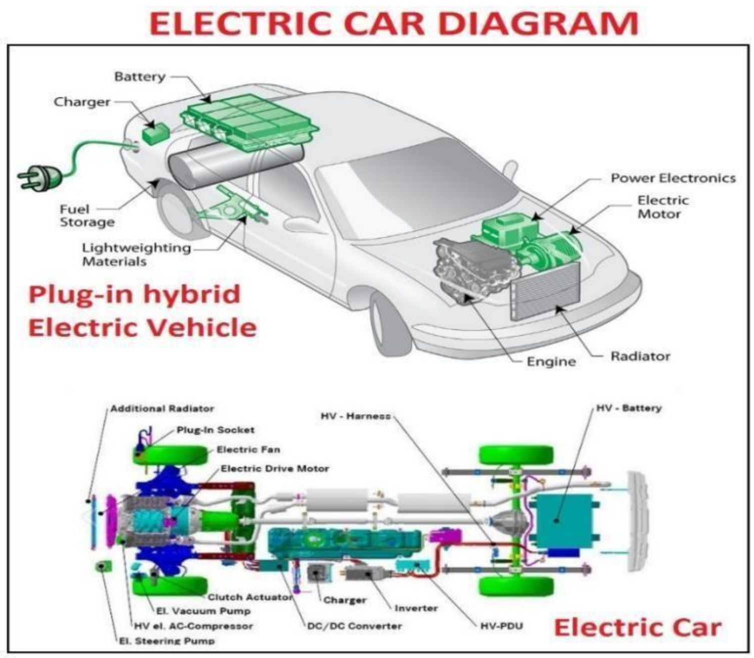

Fig.1ElectricVehicle

What is need of Ev’s:

Electric vehicles (EV's) lower emissions, improve air quality, and increase energy security by reducing dependence on foreign oil. They are economically beneficial through job creation and reduced operating expenses. EV development also leads to innovation in batteries and charging networks, which supports sustainability, economic development, and environmental conservation.

Working :

Electric vehicles (EV's) employ an electric motor and rechargeable battery in place of a combustion engine. They recharge through electrical outlets, converting grid electricity to stored energy. The motor translates this energy into motion, moving the vehicle. Regenerative braking captures energy, enhancing efficiency and increasing battery life before recharging is required.

VI. Electric Vehicle Batteries

Electric vehicle (EV) batteries are required to save and supply energy to drive electric motors rather than traditional internal combustion engines. EV's are unlike gasoline vehicles because they utilize electricity, thus a cleaner and greener means of transportation. EV batteries are required as a result of the need to curb greenhouse gas emissions and fossil fuel consumption. EV's cut tailpipe emissions, thus slowing down climate change and air pollution by decreasing carbon dioxide, nitrogen oxides, and particulate matter.

In addition, EV batteries ensure energy security by reducing reliance on foreign oil. Solar, wind, and hydroelectric power can be utilized to generate electricity for EV's, hence they are a clean mode of transportation. The development of battery technology is crucial in the sense of making EVs more efficient, longer-lasting, and cheaper. Increasing the battery capacity and charging rate will make EV's cover longer distances and charge fast, which will improve their use on a daily basis.

With research and innovation continuing, batteries in electric cars will be at the center of the bulk purchase of EV's, making them a viable choice compared to traditional cars. Improvements made to longer-lasting, high-performance batteries will propel the move toward a cleaner, greener future of transportation.

VII. EXISTING METHOD

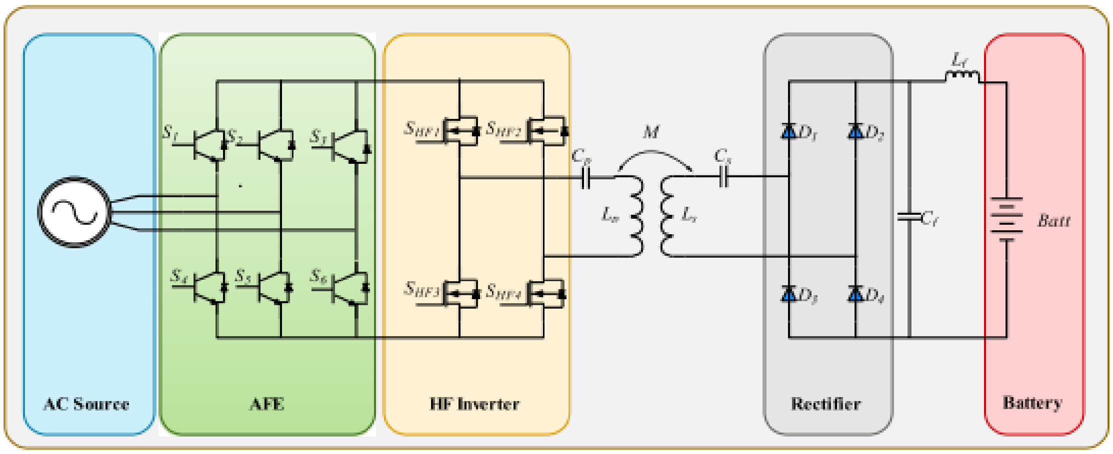

Fig.2.DiagramoftheProposed inductivepowertransfersystem

Architecture of Wireless Charging System

A road transmitter and a receiver placed under the vehicle constitute a wireless EV charging system. The transmitter generates a high-frequency alternating magnetic flux, which inductively transfers to the receiver coil and gets converted into electrical energy for EV battery charging. The two units are separated by a vacuum, while each unit consists of an independent electronic system.

The Active Front End (AFE) converter offers controllable DC voltage to power the transmitter. Grid stability is maintained through a Power Factor Corrector (PFC) by regulating the reactive power, and a high-frequency full-bridge inverter is utilized to supply the transmitter coil.

Two most essential factors that affect system efficiency are compensation topology, which offers correct current and voltage waveforms, and coil design, which affects power transfer efficiency. Circular coils offer improved energy coupling, which affects the transmitter surface and efficiency. These are essential in wireless EV charging system optimization.

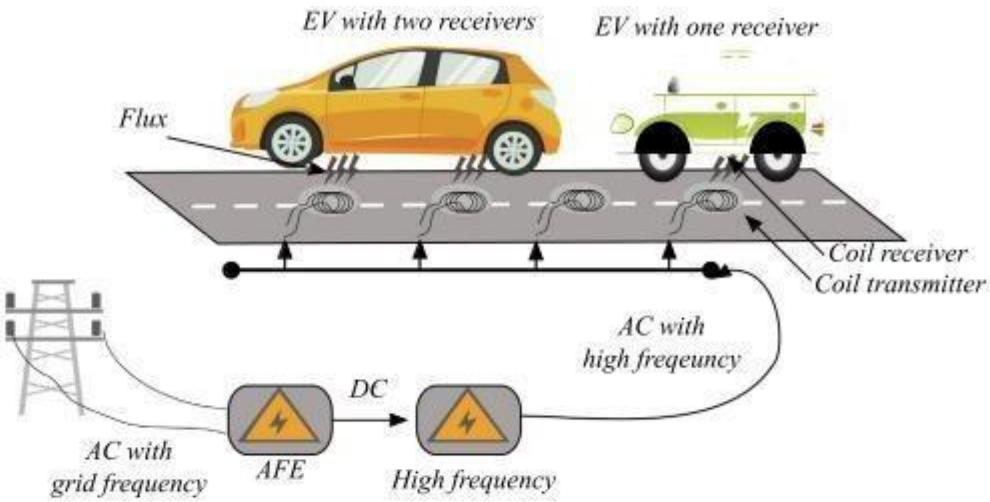

Fig.3.Wirelesstransmittersystemcomposition

VIII. ANN CONTROLLER

An Artificial Neural Network (ANN) controller is a data-driven controller that enhances the performance of Inductive Power Transfer (IPT). In contrast to PID controllers that are not ideally suited for nonlinear and time-varying conditions, ANN controllers learn and adapt dynamically by looking for patterns in data.

Why Use ANN for IPT ?

IPT systems are exposed to load variations, coil misalignment, and environmental factors. ANN controllers are superior in modeling these nonlinearities and optimize power transfer efficiency by real-time optimization of key parameters like switching frequency and voltage.

Properties of ANN Controllers

-Adaptable to changes in operating conditions.
- Real-Time Optimization: Optimizes parameters automatically for optimum performance.
- Nonlinear System Handling: Record intricate voltage, current, and power relationships.
- Quick Response: Processes data rapidly, keeping the system stable.
- Fault Tolerance: Errors are detected and corrected, increasing reliability

How ANN Works for IPT ?

ANNs are supplied with real-time measurements from sensors, learn from historical trends, generate optimal control actions, and send the correct signals to the power electronics system to transfer power stably and efficiently. Advantages ANN controllers enhance efficiency, minimize energy losses, increase system stability, and need no manual tuning. Their scalability makes them perfect for use in fields such as dynamic wireless charging, opening the door for further development of IPT technology.

IX. RESULT

PROPOSED SIMULATION RESULTS

In proposed method, the hybrid recharge system using two power sources within the vehicle. Wireless charging system for EV; this model has relied on the mutual inductance related to primary and secondary coils, it was verified only for the case of superimposing of the receiver and transmitter coils.

This is a system using mutual inductance between a transmitter coil (on the charging station) and a receiver coil (on the EV). It was tested under a condition in which the receiver and transmitter coils are ideally aligned with each other.

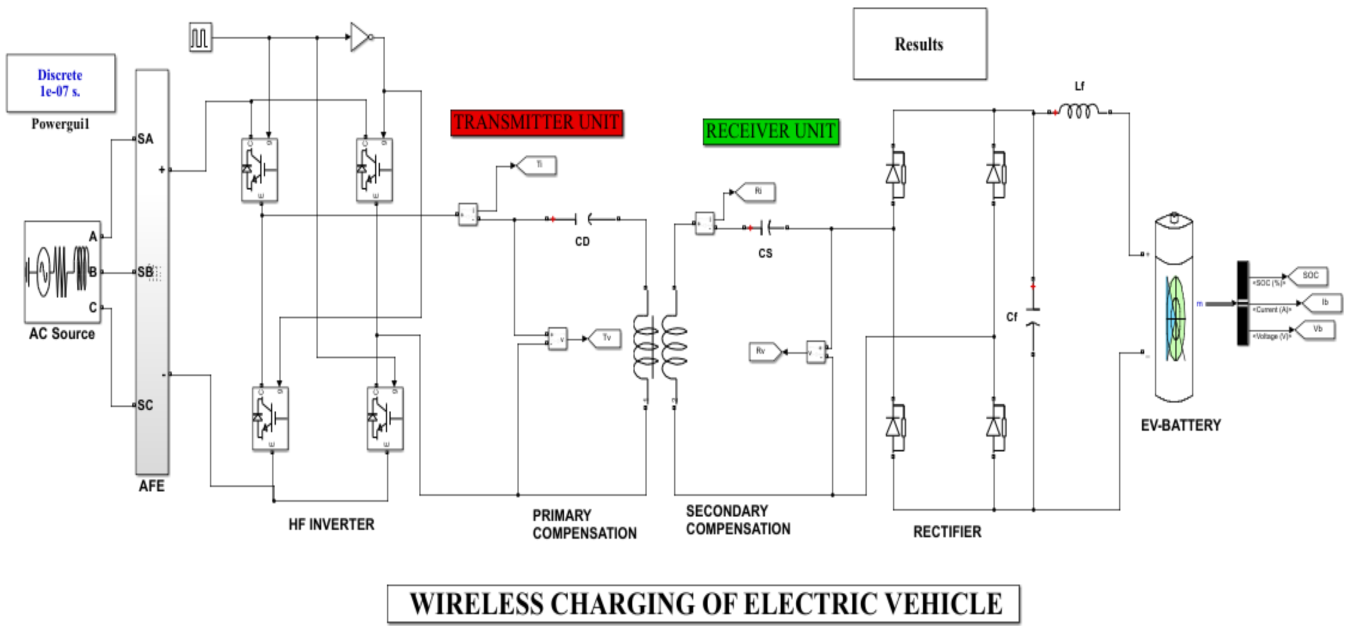

Fig.4.ProposedsimulationDiagram

Description of the Block Diagram

The block diagram indicates the Inductive Power Transfer (IPT) system of wireless charging of EV. It consists of several key components:

1.AC Source

• Delivers alternating current electricity from the power grid.

• Drives the Active Front-End (AFE) converter for processing.

2.Active Front-End (AFE)

•It has four switches (S1, S2, S3, S4) that form a rectifier-inverter bridge.

• Controls the AC input to DC prior to supplying to the high-frequency inverter.

• Controls power flow and increases efficiency.

3.High-Frequency (HF) Inverter

• Connects four switches (SHF1, SHF2, SHF3, SHF4) to switch high-frequency AC from the DC output of the AFE.

• High-frequency AC improves inductive power transfer efficiency.

• Invests energy into the transmitter coil (Lp) in the wireless transfer process.

4. Wireless Power Transfer (WPT) Coils

• Primary Coil (Lp): Located at the charging station, it produces the magnetic field.

• Secondary Coil (Ls): Mounted on the EV, it receives power through mutual inductance (M) and converts it back to AC.

• Capacitors (Cp, Cs): Help to tune resonance to increase efficiency.

5.Rectifier

• Transforms the high-frequency AC obtained from Ls into DC.

• Utilizes diodes (D1, D2, D3, D4) for rectification.

• Filter capacitor (Cf) regulates the DC output.

6.Battery System

• Charges the rectified DC power to the vehicle's battery (Batt).

• Inductor (Lr): Helps in current regulation and reduces fluctuations.

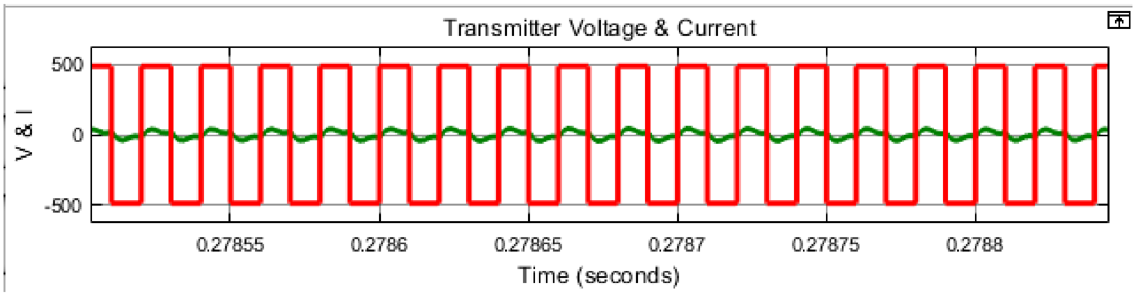

Fig.5.TransmitterVoltageandCurrent

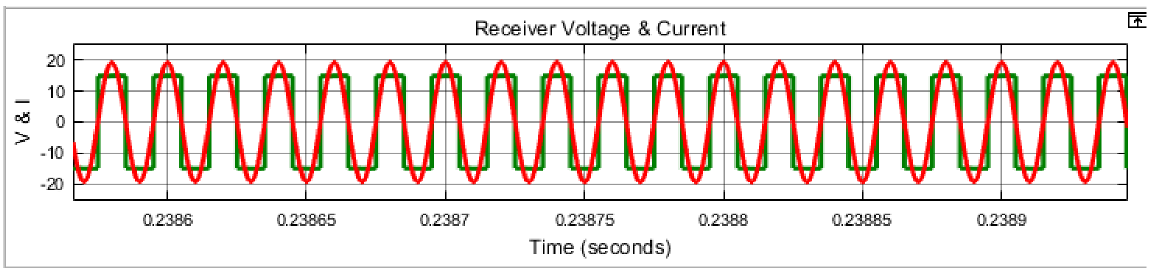

Fig.6.ReceiverVoltageandCurrent

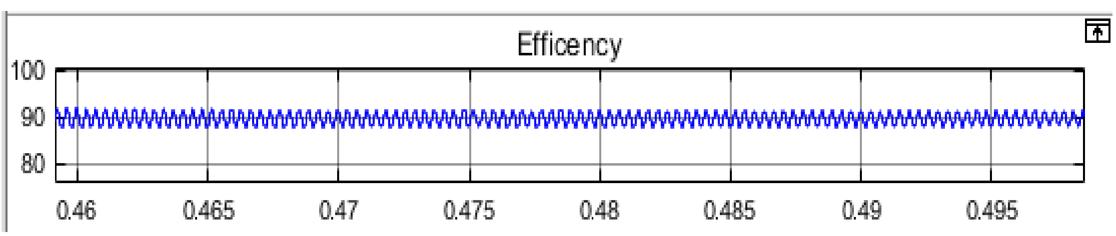

Fig.7.Graph of Efficiency

X.EXTENSION RESULTS

For improved system performance, we use an ANN (Artificial Neural Networks) controller to implement closed loop controlling in the extension system. Through dynamic parameter adjustments based on real-time feedback, the system's Performance is intended to be improved.

Performance, efficiency, and dependability are greatly improved in the Inductive Power Transfer (IPT) System by implementing a Closed-Loop ANN Controller. ANN is the perfect option for contemporary wireless EV charging systems because of its real-time learning, adaptation, and optimization capabilities.

It is made up of several layers of neurons, or processing units, that aid in the processing and analysis of information for decision-making.

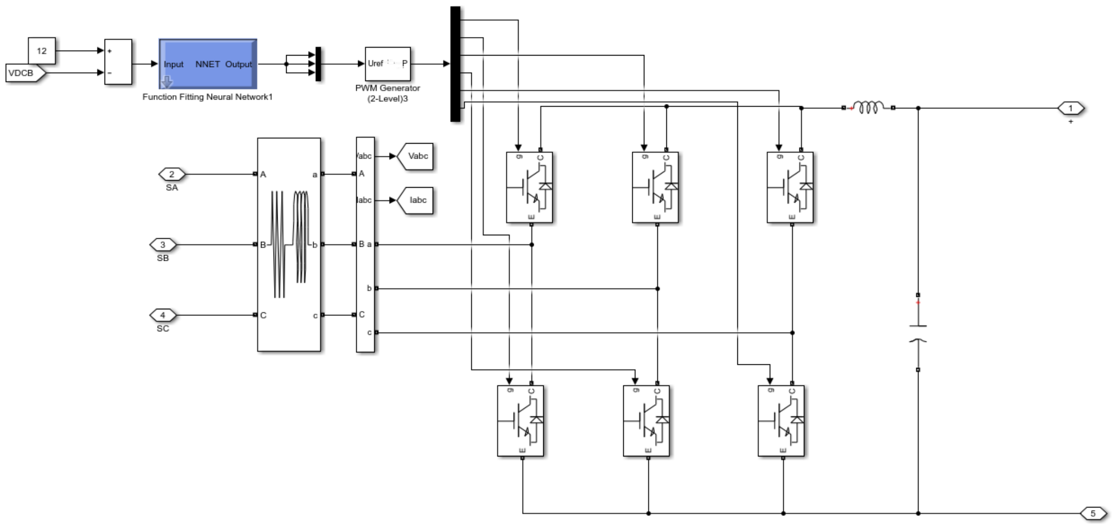

Fig.8.ANNcontrollerinAFE

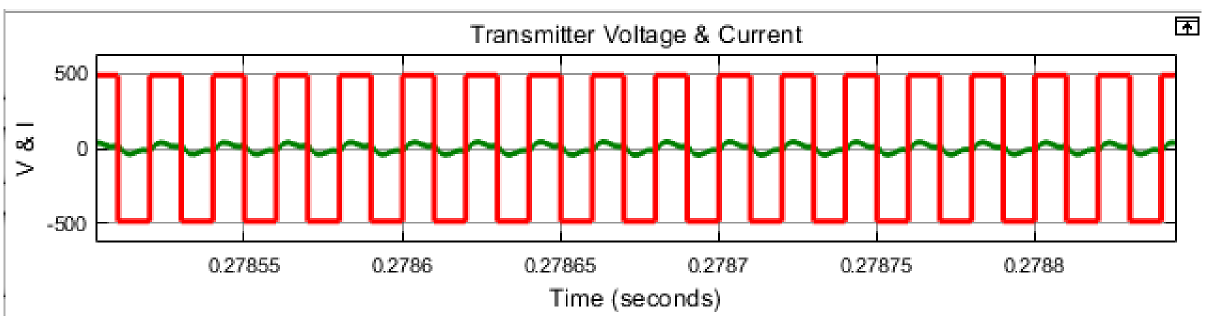

Fig.9.TransmitterVoltageand Current

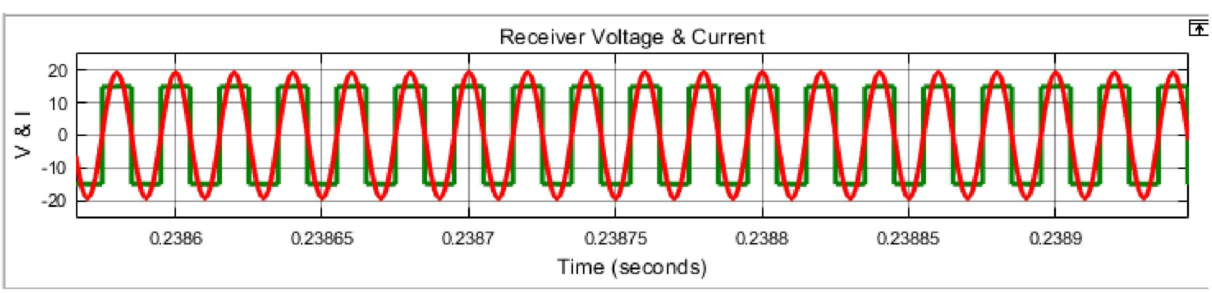

Fig.10.ReceiverVoltageand Current

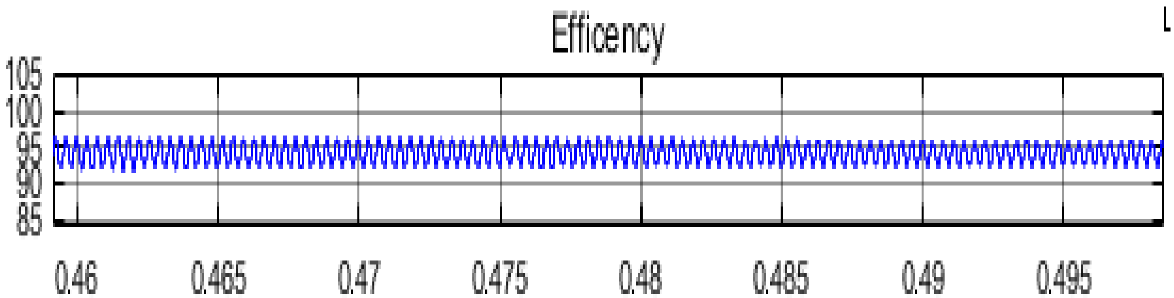

Fig.11.GraphofEfficiency

PARAMETERS	PROPOSED METHOD	EXTENSION METHOD
TRANSMITTER OUTPUT	212.1	212.1
RECIEVER INPUT	192.9	202.2
EFFICIENCY	90.94 %	95.49 %
STATE OF CHARGE {SOC}	80 %	80 %

Table.12.Comparisionofparameters

DEDUCTIVE

A comparison between an existing approach and a suggested method is shown in the table.

1.Output from the transmitter

In both cases, the transmitter's power output stays at 212.1.

2. Input from the Receiver

In the proposed technique, the power received has grown to 202.6, while in the present way, it is 192.9. A more efficient energy transfer process is suggested by the improvement in receiver input, which may be the result of enhanced energy harvesting methods, decreased interference, or better circuit design.

3. Effectiveness

Efficiency is one of the suggested method's most noticeable gains. The suggested approach provides an enhanced efficiency of 95.49%, while the current method's efficiency is 90.94%. This improvement in efficiency shows that the suggested approach is more successful in transforming transmitted power into usable energy since it reduces power losses both during transmission and reception. In the long run, this enhancement could make the system more economical and sustainable by reducing energy waste and improving overall performance.

4. Charge State (SOC)

The State of Charge (SOC) stays at 80% for both approaches, even though receiver input and efficiency have increased.
The suggested approach maintains the transmitter output and SOC constant while increasing receiver input and efficiency.

XI. SCOPEFORFUTUREWORK

Wireless Power Transfer to Electric Vehicles (EV's) stands on the threshold of significant developments, particularly in receiver coil technology. Improvements in the future will be in the direction of higher efficiency, greater range, and dynamic charging.

Critical advances are multi-coil receiver structures, boosting energy capture efficiency and reducing misalignment issues. Resonant inductive coupling and hybrid coils will improve power transfer at greater distances, allowing for efficient charging under drive conditions (dynamic wireless charging).

High-permeability magnetic core and other advanced technology materials will reduce energy loss and optimize performance. Integration into AI-based adaptive control technology will also maximize power management through real-time frequency control and coil positioning.

As more EVs come into use, large-scale rollout of smart wireless charging infrastructure will be driven by regulation and standardization. All these advancements will make WPT a viable, scalable, and seamless future solution for electric mobility.

XII. CONCLUSION

This project included a review of wireless charging of electric vehicles. It is evident that vehicle electrification is inevitable due to environment as well as energy issues. Wireless charging will be of numerous advantages over wired charging. Specifically, when the roads are electrified with wireless charging ability. The analysis of the project include the designing of a new kind of WPT device to provide high-efficiency EV battery charging. Extracted data from simulation experiments indicate the overall good performance of the proposed algorithm. The results obtained indicate that it is possible to improve 100% of the efficiency of the wireless recharge system if a dual-receiver is fitted. The results obtained indicate that the efficiency of the recharge system. Lastly, the efficiency of the proposed method is 90% of global efficiency, which assists in improving battery life.

XIII. REFERENCES

[1] Ibrahim AM, Abdel Aleem SHE, and Mousa AGE. An application of solar-powered water pumps for the mathematical analysis of maximum power points and current-based maximum power point tracking in solar photovoltaic systems. Electr Eng Int Rev 2016;11(97). https://doi.org/10.15866/iree.v11i1.8137 is the doi information.

[2] Asna M, Wahyudie A, Achikkulath P, Shareef H, Mokhlis H, and Errouissi R. An analysis of an optimal planning model for fast-charging stations for electric vehicles in Al Ain, United Arab Emirates. IEEE Access, 9:73678-94, 2021. The URL is https://doi.org/10.1109/access.2021.3081020.

[3] Ghoneim SSM, Bajaj M, Issam Z, Aymen F, and Mohammed N. The Effect of Coil Number and Position on Wireless System Performance for Charging Electric Vehicles. 2021;21:1–19; Sensors. https://doi.org/10.3390/s21134343 is the doi.

[4] Ma G, Kim MH, Lee KQ, Kamaruddin MH, Kang HS, Goh PS, et al. undersea robotic vehicles' waterproof integrity thanks to a self-healing technology. The doi is https://doi.org/10.1016/j.asej.2020.09.019. Ain Shams Eng J 2021;12:1995–2007.

[5] Younges Z, Mekhilef S, Alhamrouni I, and Reyasudin M. A gravitational search technique that uses memory to solve the microgrid's economic dispatch problem. 12:1985–94 in Ain Shams Eng J 2021. doi: https://doi.org/10.1016/j. asej.2020.10.021