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WIRELESS VEHICLE CHARGING SYSTEM USING SOLAR ENERGY

Qamar Unnisa Begum[1], Sheeba Tabassum[2], Mohd. Talha[3], Mrs. Amina Begum[4]

[1234]UG students,Assistant Professor,Electronic and Communication Engineering, Deccan College of Engineering And Engineering, Hyderabad, Telangana

ABSTRACT

Wireless charging systems are advantageous for electric cars (EVs) since they are less intrusive and more eco-friendly than traditional cable systems. This research investigates wireless power transfer techniques, which transfer electrical power without the need for physical conductors by using electromagnetic fields.Through the process of electromagnetic induction, a base station coil generates a magnetic field that causes a neighboring coil to conduct a current, allowing for wireless battery charging. Proximity can attain over 70% efficiency even though energy losses across distance provide efficiency challenges. Because solar energy is used in the project, efficiency is not as important. The project's goal is to use a demo car with an autonomous headlight system controlled by a light sensor (LDR) and a small DC motor to wirelessly charge an electric vehicle. The battery is charged while the car travels thanks to charging coils positioned along its route. When a car moves, infrared sensors detect it and turn on the street lamps. Lamp posts are controlled by a microcontroller (89C2051) that receives input from an IR sensor. Up to one amp can be obtained from a solar panel for battery charging

Keywords: Electric Vehicles(EVs), Wireless Charging, Electromagnetic Induction, Wireless power transfer, Solar Energy, Efficiency, Automatic Headlights, Light Sensor (LDR), IR sensors, Microcontroller (89C2051).

Introduction:

An electromagnetic field is used in inductive charging, also referred to as wireless charging, as a way to transmit energy between two items. Usually, a charging station uses an induction coil to create an electromagnetic field, which is then used to transfer energy to a receiving device that has an induction coil of its own. Devices can be powered directly by this transmitted energy or used to charge batteries. Electromagnetic induction, in which alternating current (AC) in the transmitter coil generates a magnetic field that induces a voltage in the reception coil, is the basic idea of inductive charging. As there are no physical connectors or wires required, wireless charging has a major convenience and user experience benefit. Applications for this technology are growing in variety, ranging from consumer electronics like tablets and smartphones to more sophisticated systems like electric vehicles (EVs) and medical equipment. Conventional inductive charging systems are convenient, but their efficiency is limited (usually between 60% and 70%) by heat and electromagnetic interference losses.Resonant inductive coupling has been the focus of recent developments in wireless charging, with an eye toward increasing range and efficiency. By guaranteeing that the transmitter and receiver coils resonate at the same frequency, this technique improves power transfer efficiency and can greatly minimize energy losses. Greater spatial freedom is another benefit of resonant inductive coupling, which makes it possible to charge objects that are not precisely aligned with the transmitter coil.

Particularly exciting is the use of wireless charging in electric cars. It lessens reliance on infrastructure and charging cables by providing a smooth and simple method for charging EVs. The wireless auto charger uses renewable energy by including solar power as the power source, which promotes sustainability and lowers the carbon footprint associated with using fossil fuels. In order to develop an effective, dependable, and environmentally responsible electric vehicle charging system, this project intends to investigate the possibilities of fusing solar energy with wireless charging technology.

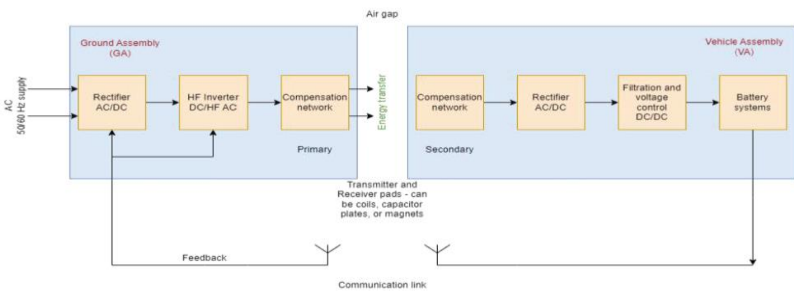
What is wireless charging?

Wireless charging is a technology that allows electronic devices to be charged without the need for physical cables. This is typically achieved through the use of electromagnetic fields to transfer energy between two objects via a transmitter (charging pad) and a receiver (device). The most common method involves inductive charging, where an alternating current is passed through a coil in the charger, generating a magnetic field. When a device equipped with a compatible receiver coil is placed on the charging pad, the magnetic field induces a current in the receiver coil, which is then converted back into direct current to charge the device's battery. Wireless charging is widely used for smartphones, smartwatches, and other portable electronics, offering convenience and reducing the wear and tear associated with plugging and unplugging charging cables..

What is the use of wireless charging?

Wireless charging offers numerous advantages that enhance the user experience with electronic devices. Primarily, it provides convenience by allowing users to charge their devices without the hassle of connecting cables; simply placing the device on a charging pad initiates the charging process. This convenience extends to reducing wear and tear on both the charging ports and cables, as there is no need for constant plugging and unplugging. Additionally, wireless charging improves safety by minimizing the risks associated with frayed cables and potential electric shocks. The technology also contributes to a tidier and more aesthetically pleasing environment by eliminating cable clutter. Some wireless charging pads can simultaneously charge multiple devices, such as smartphones, smartwatches, and wireless earbuds, catering to users with several gadgets. Furthermore, the widespread adoption of standard protocols like Qi ensures that a variety of devices from different manufacturers can be charged using the same wireless charging pad, enhancing compatibility and user convenience.

Methodology:



The architecture of wireless charging for electric vehicles consists of several key components designed to work seamlessly together. Central to this system is the integration of solar panels, which capture and convert solar energy into electrical power. This power is regulated by a DC-DC converter and managed by a microcontroller, ensuring optimal energy flow. Inductive coils, strategically aligned, facilitate the wireless transfer of energy from the charging station to the vehicle. Finally, a Battery Management System (BMS) ensures safe and efficient charging, maintaining battery health and longevity.

The methodology for the wireless vehicle charger using solar energy involves a comprehensive, multi-step approach. This includes system design, component selection, circuit implementation, and rigorous testing to ensure efficiency and reliability.

A.System Design

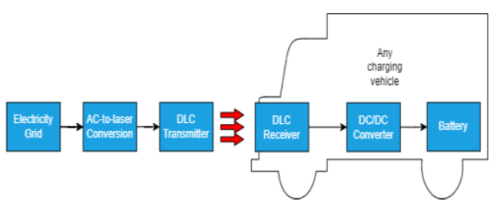


Fig 2: Block diagram

The design of the system that integrates solar panels to capture solar energy is the initial stage of the project. The first step in the design process is figuring out the solar panels' parameters to make sure they can produce enough power in a variety of environmental circumstances. The arrangement and setup of the infrastructure for charging is also part of the system design, which aims to maximize power output and efficiency.The first step in the wireless charging architecture's system design is to choose highly efficient solar panels that can produce enough power.

B. Component Selection

The paper includes detailed descriptions of hardware components, circuits, and controllers used in the project (e.g., 555 Timer, IR sensing circuits).The next step is the selection of appropriate components, which is crucial for the success of the project. The key components include:

- **Solar Panels**: High-efficiency photovoltaic panels are selected to maximize energy capture.
- **Microcontroller**: The 89C2051 microcontroller is chosen for its capabilities in managing the system operations, including the regulation of power flow and sensor integration.
- **Inductive Coils**: Primary and secondary coils are designed to facilitate efficient wireless power transfer. The design focuses on achieving optimal resonance and alignment to minimize energy losses.
- **DC-DC Converter**: This component is essential for regulating the voltage from the solar panels to the levels required by the charging system.
- **Battery Management System (BMS)**: The BMS ensures the vehicle's battery is charged safely and efficiently, preventing overcharging and optimizing battery life.

C. Circuit Implementation

In this phase, the selected components are integrated into a functional circuit. The solar panels are connected to the DC-AC converter, which regulates the voltage. The microcontroller is programmed to control the power flow and manage the inductive coils. The coils are positioned to ensure optimal alignment, maximizing the efficiency of power transfer. Additionally, IR sensors are incorporated to detect the presence of a vehicle and automatically initiate the charging process.

D. Testing and Optimization

Extensive testing is conducted to evaluate the system's performance under various conditions. This includes assessing the efficiency of energy transfer, the effectiveness of the solar panels in different lighting scenarios, and the overall reliability of the system. The data collected during testing is used to optimize the configuration of components and refine the control algorithms, enhancing the overall performance and efficiency of the system.

E. Integration with Vehicle

The final phase involves integrating the wireless charging system with the electric vehicle. The secondary coil is installed in the vehicle, and the BMS is configured to communicate with the microcontroller. Real-world testing ensures that the system operates seamlessly and meets the practical requirements for a sustainable and efficient wireless charging solution powered by solar energy.

Wireless battery charging

FIG NO 4: Wireless battery charging

Wireless charging of electric vehicles continues to be one of the most investigated areas of wireless power transfer. By lowering the dependency on fossil fuels, electric vehicles provide a sustainable and environmentally safe alternative for fuelling our vehicles well into the future.

However today's electric automobiles are limited to an average travel distance of between merely 10 and 40 miles before they require charging. Initiating a difficult charging process that needs access to a charging point, charging connections, and a multiple-hour wait before the vehicle is sufficiently charged. With the arrival of wireless charging, the charging experience is poised to become a seamless one enabling the convenient charging of electric cars whether parked or on the move.

Wireless charging through solar energy

The advantages of wireless charging combined with the sustainability of solar power are offered by wireless charging powered by solar energy. Using this technology, electronics can be wirelessly charged using solar energy. A wireless charging pad is powered by electrical energy produced by a solar panel that absorbs sunlight. Devices that are compatible with this pad, like smartphones, smartwatches, and other portable electronics, can receive energy transmissions wirelessly.There are a number of noteworthy benefits of integrating solar energy into wireless charging devices. By lowering carbon footprints, depending less on fossil fuels, and using renewable energy, it supports environmental sustainability. Due to solar panels' ability to continually gather energy during the day, this technology also improves convenience and flexibility—especially in outdoor settings or regions without easy access to electrical outlets. Furthermore, in situations involving disaster relief, isolated areas, or outdoor enthusiasts who must keep their gadgets charged while on the go, this combination can be quite helpful.

How does solar energy work?

Wireless solar energy creates a practical and environmentally friendly method of charging electronic gadgets by fusing solar power technology with wireless charging capabilities. First, sunlight is captured by solar panels, which then use photovoltaic cells to turn it into electrical energy. This energy is either used right away or stored in batteries to be used later on in the day or at night when there isn't any sunlight. The stored energy is then used to power a wireless charging pad, which has a transmitter coil inside of it that, when electricity passes through it, creates an alternating magnetic field. A receiver coil within a suitable device—like a smartphone or smartwatch—is triggered when the gadget is positioned on or close to the pad.

Through electromagnetic induction, the magnetic field creates an electric current in the receiver coil that is subsequently transformed back into direct current to charge the battery of the gadget. This smooth procedure combines the advantages of solar electricity for the environment with wireless technology to enable the wireless charging of gadgets using renewable solar energy.

Functional Description:

The focus of the project is Wireless Power Transmission (WPT), a technique that uses resonant induction for mid-range and inductive coupling for short-range power transfer to effectively transport electric power over the air without the need for wires. This technology is especially useful in locations where traditional wiring is not possible. This technology is especially useful in locations where traditional wiring is not possible. Inductive Power Transfer (IPT), also referred to as electromagnetic induction or magnetic resonance, is the basis for wireless charging. It entails sending and receiving an electrical current between two objects by means of coils that produce and detect an electromagnetic field.First, solar and wind energy are converted into high-frequency alternating current (AC). Through the transmitter circuit, this AC is delivered to the transmitter coil, where it creates a magnetic field that changes over time. This magnetic field creates a current in the receiver coil when it is within a certain distance. Magnetic or resonant coupling is then used to transfer the energy from the magnetic field between the transmitter and reception coil. The receiver circuit transforms the induced current in the receiver coil into direct current (DC), which is then utilized to charge the battery of the electric vehicle.The transmitter circuit, which transforms energy sources into high-frequency AC, the receiver circuit, which transforms the received AC into useable DC, and the transmitter coil, which creates the magnetic field from the AC supplied by the transmitter circuit, are essential parts of this system. The receiver coil also induces a current to be converted to DC upon receiving the magnetic field. Three requirements must be met by the system for effective mid-range power transfer: a big air gap to allow for flexible transmitter and receiver positions; high power to provide adequate transmission to the receiving device; and high efficiency to ensure minimal power loss. For short-range transfers, electromagnetic induction techniques offer excellent efficiency; however, magnetic resonance coupling can increase the transfer range without sacrificing efficiency. Because of this, wireless power transfer is particularly helpful in situations where running wires is difficult or where user convenience is crucial, like when charging electric vehicles. Convenience—getting rid of physical plugs and connectors—flexibility—enabling the deployment of charging infrastructure in a scalable and flexible manner—and safety—enabling safe power transfer through non-metal objects and over air gaps—are some of the benefits of wireless charging. With advancements in efficiency, range, and power transmission, wireless power transfer technology is becoming a viable option for a number of potential uses in the future.

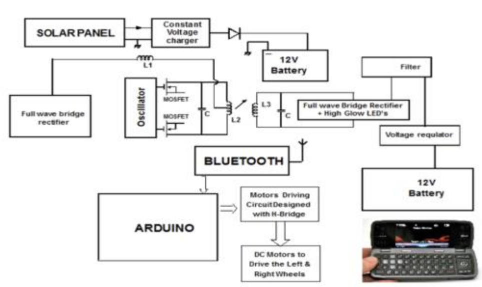


FIG NO:5 BLOCK DIAGRAM

The project's block diagram shows how Wireless Power Transmission (WPT) works with wind and solar energy as the main energy sources. It consists of a number of essential parts and the connections between them, each of which has a distinct purpose within the system as a whole. First, solar and wind energy are converted into electrical energy by solar panels and wind turbines. The 12V battery is then charged with this energy using a constant voltage charger, which maintains a controlled voltage supply and stores energy for later use. A full-wave bridge rectifier then controls the energy from the battery, converting any alternate current (AC) produced by the system into direct current (DC).An oscillator circuit produces the necessary frequency for AC conversion, which is essential for effective power transmission, in conjunction with Metal-Oxide-Semiconductor Field-Effect Transistors (MOSFETs). To ensure a steady supply of voltage and current, inductors (L1, L2, L3) are placed inside the circuit to filter and control the power flow.The regulated energy powers the transmitter circuit, which then transforms it into high-frequency AC and sends it to the transmitter coil. By producing a time-varying magnetic field, this coil establishes the prerequisites for inductive power transfer. This magnetic field creates a current in a receiver coil when it is close. The receiver circuit then transforms the induced current back into DC, offering a useful power source for charging the battery of an electric car.Sensitive parts, including the Bluetooth module and Arduino microcontroller, are guaranteed a steady power source by a voltage regulator. To guarantee that enough energy is transmitted to the receiving device, the system as a whole must maintain high efficiency, control a wide air gap for efficient energy transfer, and support high power levels.

Experiment and Result Analysis

Several settings and combinations were tested in the wireless power transmission studies to maximize the energy transfer's efficiency and range. Evaluating various coil designs and how well they transmit power wirelessly was the main objective.

Design and Testing of Coils

At first, a variety of gauge wires, turn ratios, and coil sizes were used to wind various kinds of magnetic coils. The goal of these tests was to identify the primary and secondary coil arrangement that maximizes efficiency. To determine the best configuration for energy transfer, a range of coils with varying turn ratios and wire gauges—including 21 SWG—were tried. It was discovered through this iterative procedure that coils with six turns each, wound with 21 SWG wire and a ring size of 1½ inches, performed the best. When compared to other evaluated systems, this combination greatly boosted power transmission efficiency and range.

Range of Power Transmission

The coils' ultimate arrangement permitted an effective transmission range of about 60 mm. This distance was attained by carefully fine-tuning the resonant circuits, which included adjusting the capacitance and inductance levels to guarantee optimal power transfer efficiency. The outcomes showed that the system might attain a respectable range for real-world uses, including wirelessly charging mobile devices, with careful adjustment.

Power Optimization and Prototype Constraints

An extra secondary coil was taken into consideration in order to increase the power at the secondary side. The goal of this configuration was to increase the device's power reception, which would enable more effective charging of gadgets like cell phones. However, due to power supply limitations and budgetary constraints, the prototype module was built with a low-power transmitter. Notwithstanding these drawbacks, the trials provide a strong basis and proof of concept for expanding the system in subsequent iterations to a higher power transmitter with a longer range.

Computer programs and role-playing

Keil Vision was one of the applications used in the project to simulate the microcontroller code. Before deploying the applications on the real hardware, they could be tested and debugged in a simulated environment using the µVision simulator. Through this procedure, the software components of the system, including the Bluetooth module's communication protocols and the microcontroller's control logic, were verified to be operating correctly and effectively.

Objective

- Examine the technologies underlying electric car wireless charging devices.
- Consider the benefits and drawbacks of wireless charging solutions.
- Examine current advancements and breakthroughs in the wireless charging space.
- Give a thorough explanation of how wireless charging operates.
- The condition of technology at the moment.

Results:

The results of the trials showed that the optimum performance was obtained with 21 SWG (Standard Wire Gauge) wire coils. These coils, configured with a 1½-inch ring size and six turns, achieved an effective transmission range of approximately 60 mm. This specific arrangement significantly enhanced the power transmission efficiency compared to previous setups. The prototype successfully demonstrated the feasibility of wireless charging even when using limited power sources. Furthermore, it highlighted the potential for scalability to accommodate greater power applications, indicating that the technology could be adapted for more demanding uses. Looking ahead, future advancements in wireless charging technology may further improve both the efficiency and the transmission range. Such improvements would make wireless charging an even more viable option for regular usage, potentially transforming how we power various electronic devices and electric vehicles on a daily basis.

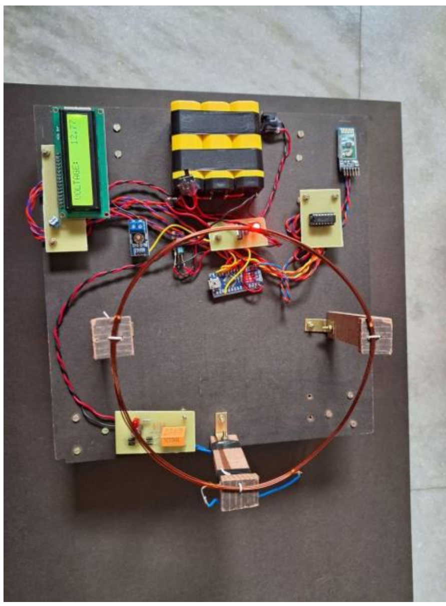


FIG NO: 6 Electric Vehicle Model

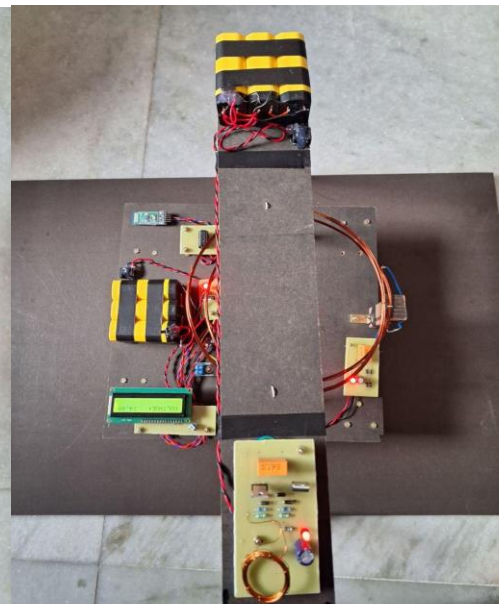


FIG NO 7: Inductive Charging

FUTURE SCOPE

Wireless electric vehicle (EV) chargers have a bright future ahead of them thanks to a number of factors:

1. Convenience: EV users will find wireless charging more convenient since it does away with the need for physical wires. By enabling automated charging without the need for human involvement, this technology improves user experience and increases the appeal of EV adoption.
2. metropolitan Infrastructure: Wireless charging infrastructure can be easily incorporated into parking lots, roadways, and public transportation hubs in heavily populated metropolitan areas. By offering practical charging choices in places where standard charging stations might not be feasible, this integration encourages the adoption of electric vehicles.
3. Autonomous Vehicles: Wireless charging can be included into the functioning of autonomous vehicles as they become more common to provide continuous charging without the need for human interaction. This would increase the autonomous EV fleets' operational efficiency and range.
4. Efficiency and Standardization: As wireless charging technology advances, energy losses are decreased and efficiency is increased, making it a more practical option for charging electric vehicles. In order to guarantee compatibility across various charging methods, standardization initiatives are also in progress, which will accelerate adoption.

CONCLUSION

The carried out experiments proved that employing inductive coupling with appropriately tuned resonant circuits, wireless power transmission is feasible. The transmission efficiency and range were greatly increased by the ideal coil design and setup. Even though the prototype's power supply was restricted, the results showed that a more potent and efficient wireless charging system may be created with additional research and scalability. This experiment paves the path for future developments in this field by demonstrating how wireless power transmission can improve the efficiency and ease of charging electronic gadgets.

Due to its ease of use and environmental friendliness, wireless charging is thought to be a superior option than conventional wired charging methods. Additionally, it avoids the risks and inconveniences that come with using cables and mechanical couplings. Additionally lowering range anxiety and improving system efficiency are wireless charging solutions. In general, mutual coupling, microwave, or laser technology are used for wireless power transmission. However, for wireless charging, only methods based on mutual coupling are typically employed. For contactless power transfer and electric device charging, mutual coupling-based methods such as capacitive and inductive power transfer are used. Ultimately, though, inductive power transfer is the best technique for wirelessly charging electric cars since it offers a number of benefits.

When building the project, there is a great deal of excitement around the essential topic of wireless power transfer. To get better results, more research is needed in the field of wireless electrical energy transmission between two magnetically connected coils. Throughout our trail trips, we have wound a variety of magnetic coils. We have experimented with gauge wires, turns ratios, coil sizes, and other variations. In conclusion, we have concentrated on a single set of coils that have six turns in each of their primary and secondary coils. These coils are wound with 21 SWG wire and have a ring size of 11-2/8". We discovered that, in comparison to other coils, the range improved marginally with these coils.

REFERENCES

Research Papers:

1. Energy Efficiency in wireless Networks By Oswald Jumira, Sherali Zeadally
2. Electromagnetic Field Measurement in the near field By Hubert Trazaska
3. Electromagnetics for Engineers By Steven E. Schwarz
4. Fields from Electric Power By Prof. M. Granger Morgan
5. Linear Integrated Circuits – By: D. Roy Choudhury, Shail Jain
6. Digital Electronics. By JOSEPH J.CARR
7. Mohammed, S.A.Q.; Jung, J.W. A Comprehensive State-of-the-Art Review of Wired/Wireless Charging Technologies for Battery Electric Vehicles: Classification/Common Topologies/Future Research Issues. *IEEE Access* **2021**, *9*, 19572–19585. [CrossRef] Jang, Y.J. Survey of the operation and system study on wireless charging electric vehicle systems. *Transp. Res. Part C Emerg. Technol.* **2018**, *95*, 844–866. [CrossRef]
8. Machura, P.; Li, Q. A critical review on wireless charging for electric vehicles. *Renew. Sustain. Energy Rev.* **2019**, *104*, 209–234. [CrossRef]
   Panchal, C.; Stegen, S.; Lu, J. Review of static and dynamic wireless electric vehicle charging system. *Eng. Sci. Technol. Int. J.* **2018**, *21*, 922–937. [CrossRef]
9. Ching, T.; Wong, Y. Review of wireless charging technologies for electric vehicles. In Proceedings of the 2013 5th International Conference on Power Electronics Systems and Applications (PESA), Hong Kong, China, 11–13 December 2013; IEEE: Piscataway, NJ, USA, 2013; pp. 1–4.
10. Palani, G.; Sengamalai, U.; Vishnuram, P.; Nastasi, B. Challenges and Barriers of Wireless Charging Technologies for Electric Vehicles. *Energies* **2023**, *16*, 2138. [CrossRef]
11. Okasili, I.; Elkhateb, A.; Littler, T. A review of wireless power transfer systems for electric vehicle battery charging with a focus on inductive coupling. *Electronics* **2022**, *11*, 1355. [CrossRef]
12. Ahmad, A.; Khan, Z.A.; Saad Alam, M.; Khateeb, S. A review of the electric vehicle charging techniques, standards, progression and evolution of EV technologies in Germany. *Smart Sci.* **2018**, *6*, 36–53. [CrossRef]
13. Chen, F.; Taylor, N.; Kringos, N. Electrification of roads: Opportunities and challenges. *Appl. Energy* **2015**, *150*, 109–119. [CrossRef] Brecher, A.; Arthur
14. Li, H.L.; Covic, G.; Hu, P.A. *A High Frequency AC-AC Converter for Inductive Power Transfer (IPT) Applications*; IntechOpen: London, UK, 2012.
15. Dai, J.; Ludois, D.C. Capacitive Power Transfer Through a Conformal Bumper for Electric Vehicle Charging. *IEEE J. Emerg. Sel. Top. Power Electron.* **2016**, *4*, 1015–1025. [CrossRef]
16. Ludois, D.C.; Erickson, M.J.; Reed, J.K. Aerodynamic Fluid Bearings for Translational and Rotating Capacitors in Noncontact Capacitive Power Transfer Systems. *IEEE Trans. Ind. Appl.* **2014**, *50*, 1025–1033. [CrossRef]
17. Kim, J.; Bien, F. Electric field coupling technique of wireless power transfer for electric vehicles. In Proceedings of the IEEE 2013 Tencon-Spring, Sydney, NSW, Australia, 17–19 April 2013; IEEE: Piscataway, NJ, USA, 2013; pp. 267–271. Liu, C.; Hu, A.P.; Wang, B.; Nair, N.K.C. A capacitively coupled contactless matrix charging platform with soft switched transformer control. *IEEE Trans. Ind. Electron.* **2011**, *60*, 249–260. [CrossRef]
18. Liu, C.; Hu, A.P.; Nair, N.K. Modelling and analysis of a capacitively coupled contactless power transfer system. *IET Power Electron.* **2011**, *4*, 808–815. [CrossRef]
19. Leskarac, D.; Panchal, C.; Stegen, S.; Lu, J. PEV charging technologies and V2G on distributed systems and utility interfaces. *Veh.-Link. Electr. Veh. Smart Grid* **2015**, *79*, 157–209.