

A Bidirectional Wireless Power Transfers for Electric Vehicle Charging in V2G and G2V Systems

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Abstract: This paper describes the design and implementation of a Bidirectional Wireless Power Transfer (BWPT) system for EV charging and V2G integration as a key component of next-generation smart grid technologies. Grid-to-vehicle and vehicle-to-grid energy transmission between the EV and power grid is efficient, wireless, and contactless using the suggested technology. The hardware includes an Arduino UNO control module, a microcontroller-based logic processing board, receiver and transmitter boards, and an assembly of coils for inductive power transmission. A bidirectional DC-DC converter facilitates the transfer of energy in both directions and maintains its amplitude. A rectifier converts AC to DC, and a driver board controls the switching of power electronic devices. All units share a control panel and an AC-DC transformer for electrical isolation. The method transfers electricity wirelessly at 12 V via mutual inductance between two coils 30 cm apart. Eliminating plug-in connectors and mechanical wear makes the plugless system safer. Its flexibility makes it perfect for autonomous or dynamic charging applications. The system is designed for high efficiency, reliability, and scalability, while enabling two-way power flow in the smart grid. The paper validates the practicality and real-world application of BWPT systems for EV and V2G applications.

Keywords: Wireless Power Transfer; Inductive Power Transfer; Vehicle-To-Grid; Bi-Directional Charging; Smart Grid Technology; Electric Vehicles; DC Conversion; Energy Transfer; Mutual Inductance.

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1. Introduction

The trend of advancements in electric vehicle (EV) technology and global movement towards the integration of renewable energy have created high demand for intelligent charging infrastructures, among which bidirectional wireless power transfer (BWPT) systems have been regarded as potential solutions with features such as not only wirelessly charging electric vehicles but also providing the capability of feeding back energy to the grid via vehicle-to-grid (V2G) mode to enhance grid reliability, energy flexibility, and user comfort as well as eliminate issues of wear and tear, physical connector, safety risk, and restricted scalability in dynamic operating conditions of conventional plug-in charging infrastructures [1]. The BWPT system adopts inductive power transfer (IPT) technology based on mutual inductance of two coils—one mounted on the charging pad and the second embedded inside the vehicle-to facilitate high-frequency resonant energy transfer over an air gap without direct electric

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contact and enabling transfer of energy safely even under adverse or dynamic conditions, which is particularly beneficial in autonomous charging applications or public transportation systems where less human involvement is preferable; apart from the basic hardware components such as coils, inverters, and rectifiers, the integration of a bidirectional DC-DC converter is pivotal in enabling dual-mode operation of the system to provide the transfer of power from the grid to the battery during discharging and from the battery to the grid during charging, which not only enhances efficiency of energy utilization but also provides peak shaving, load levelling, and emergency backup during grid failure [2].

Furthermore, the integration with a battery management system (BMS) and control units like microcontrollers or Arduino platforms allows real-time monitoring and control of key parameters like battery voltage, current, and state of charge (SOC) through the execution of control algorithms usually employing PI or PID controllers to dynamically control switching behaviour of power electronic converters and control energy flow to maximize system performance and prevent phenomena like overcharging, deep discharge, and thermal runaway; utilization of a full-bridge inverter at the transmitter side and full-bridge rectifier at the receiver side allows DC-to-high-frequency-AC and vice versa conversion, respectively, required for efficient IPT. High-frequency operation significantly reduces the size of passive components, thereby enhancing power density and overall system compactness [3]. The system also utilizes usually an LC resonant circuit tuned to a target frequency for maximum efficiency by minimizing reactive power losses and allowing zero voltage switching (ZVS) or zero current switching (ZCS) in power devices, enhancing switching efficiency and minimizing electromagnetic interference (EMI) even further; bidirectional converter, usually implemented in buck-boost or full-bridge topology, takes care of control of voltage levels on either side of the transfer path as well as charging of the battery with a stable and suitable charging current while also allowing energy return to the grid when needed; during V2G operating mode [4].

The vehicle is effectively utilized as a distributed energy storage system capable of feeding energy to the grid during peak demand times or frequency regulation events, enabling a more resilient and balanced power system and making it possible to achieve a higher penetration of intermittent renewable energy sources like solar and wind; from a simulation point of view, simulation of the system in MATLAB/Simulink allows detailed analysis of electrical characteristics, control behaviour, and system dynamics under different scenarios like load change, battery SOC variation, and switching between G2V and V2G modes, which is of utmost importance for design verification before hardware implementation. The simulation uses measurement and feedback blocks for current, voltage, and SOC monitoring, control logic to decide mode of operation, PWM signal generation for converter switches, and visualization tools for monitoring system performance, making it an entire test environment for design optimization and control strategy optimization; in short, bidirectional wireless power transfer system for electric vehicle charging and V2G operation is a revolution in smart grid and electric mobility development, making wireless technology's comfort and safety meet bidirectional energy control's intelligence and flexibility, providing not just an enhanced user experience but also valuable benefits to grid operators and energy ecosystems through enabling real-time energy.

2. Literature Review

Wireless power transfer (WPT) technology development has been a vital innovation in the electric vehicle (EV) charging field, bridging the gaps in wired charging infrastructure limitations while enhancing convenience, safety, and automation in power supply. The pioneering work by Li and Mi, [8] is a comprehensive review of WPT concepts, technologies, and system configurations. The authors focus on inductive and resonant coupling as the fundamental energy transfer mechanisms in EV applications and discuss topics like alignment, coupling coefficient, coil design, and compensation topologies. The paper also assesses system efficiency and sensitivity of alignment and offers control strategies and power electronics interface techniques that offer optimal performance for various operating modes. It emphasises the need for high-frequency inverters and advanced compensation networks to enhance the dynamic and static performance of WPT systems, with a particular focus on safety, electromagnetic field control, and tolerance to misalignment. The article explains how WPT for EVs is revolutionising the user experience and setting the foundations for both dynamic and static charging scenarios, paving the way for higher grid interaction and energy management [5].

Supported by this research, Madawala and Thrimawithana [9] investigate the bidirectional mechanism of power transfer — a crucial feature in Vehicle-to-Grid (V2G) systems. The authors introduce a new inductive interface for facilitating efficient bidirectional energy transfer — from grid to vehicle (G2V) and vice versa (V2G). It utilises high-frequency resonant power conversion to modulate energy transfer with isolation and enhanced efficiency. The article focuses on control schemes for management of bidirectional operation, reactive power compensation, and grid support. By presenting the potential of WPT systems for both energy transmission and as a catalyst technology for distributed energy resources and grid support devices, through a high-performance control structure that supports smooth switching between charging and discharging modes, the paper establishes the potential for WPT systems [6]. The paper then details the technical requirements and optimisation parameters necessary for widespread deployment, including coupling variance management, power factor correction, and energy management protocols. In the seminal paper by Kurs et al. [2], strongly coupled magnetic resonances are proposed and experimentally demonstrated.

This research makes an important contribution to mid-range WPT systems, as it demonstrates that resonant bodies can transfer energy with great efficiency over distances that are several times their size. The authors present a physical and mathematical model of coupled resonator interaction and experimentally demonstrate that power transfer efficiency is very high in medium ranges, even with non-resonant bodies. The work provides a theoretical and experimental foundation for the majority of contemporary WPT systems, influencing follow-up design and material selection. The concept of non-radiative power transfer through evanescent wave coupling has totally transformed the possibility of utilising efficient, secure, and alignment-insensitive EV chargers that can be integrated into roads or garages with minimal infrastructure changes [7]. Fnato et al. [4] present the body of WPT techniques, examining the capacitive coupling phenomenon in their paper. Although inductive coupling is the weaker of the two methods, the authors propose a new method that utilises an active negative capacitor to enhance coupling performance and stability. The system utilises switched-mode excitation and advanced impedance control to enhance power-handling capability and compensate for variations in load and distance [8].

This research contributes valuable knowledge to the WPT area by demonstrating capacitive WPT as a viable solution for short-range, high-frequency applications, provided that proper circuit design and regulation are employed. The method promotes lightweight system implementations and offers new opportunities in low-power EV applications like electric bicycles, scooters, and auxiliary systems. Finally, Esteban et al. [3] conduct a detailed comparison of various power supply architectures employed in WPT systems. The research categorises systems into three main types: source converters, impedance networks, and load-side rectification, and compares their performance in terms of efficiency, cost, complexity, and scalability. The authors contrast single-stage and multistage power converters, evaluate zero-voltage switching and zero-current switching topologies, and provide insight into soft-switching methods that enhance converter efficiency at high frequencies [9]. They further investigate various rectification and regulation techniques applied on the EV side to manage variable input voltage and provide stable battery charging profiles. Their research helps designers choose proper converter architectures for given WPT system specifications and focuses attention on real-world deployment considerations such as thermal management, EMI suppression, and modular scalability.

3. Methodology

The system utilises a Bidirectional Wireless Power Transfer (BWPT) system for Vehicle-to-Grid (V2G) operations and electric vehicle (EV) charging, and is available in two models. The first process employs a basic wireless power transfer system through inductive coupling for one-way energy transmission from the grid to the battery of the EV [10]. The other approach employed is a sophisticated model utilising a bidirectional DC-DC converter and feedback control to facilitate charging (G2V) and discharging (V2G) modes, thereby emulating a smart energy system in real-life applications. For the initial scheme, the input voltage is provided by the DC power source. The voltage is supplied to a full-bridge inverter, which converts DC voltage to an AC of high frequency. Pulse-width modulation (PWM) signals control four power electronic switches, such as MOSFETs, in the inverter. An AC output of high frequency is required for effective inductive power transfer and is transferred to the primary of the resonant circuit. This resonant circuit comprises the transmitter coil and series capacitors that resonate the system to a desired resonant frequency, aiming to ensure maximum energy transfer and minimise reactive power loss. The transmitter coil produces an alternating magnetic field that is magnetically coupled to an equal receiver coil, which is shielded at approximately 30 cm.

The receiver coil, by mutual inductance, picks up this magnetic field and induces an alternating voltage. The developing AC voltage is then rectified by a full-bridge rectifier to receive DC power, which can be utilised to charge the battery. The output is then filtered and supplied to a resistive or battery load to mimic EV charging. This model provides a proof of concept for inductive wireless power transfer, as well as assists in understanding fundamental concepts such as resonance, mutual inductance, and simple power conversion. The second model demonstrates an enhanced and efficient BWPT system with bidirectional power supply, which is very important in V2G applications. The simulation begins with a DC source applied to a full-bridge inverter, which generates high-frequency AC. The AC power is transmitted through the transmitter coil to the receiver coil through magnetic coupling. On the receiving side, the AC is rectified and converted into DC. But in this model, the DC power is controlled by a bidirectional DC-DC converter. This converter handles the flow of power. In G2V mode, it operates in buck mode to lower the voltage for charging the EV battery. While in V2G mode, IGBTs operate in boost mode when the grid requires them to supply power and the battery is sufficiently charged. IGBTs then increase the battery's voltage and supply power back to the grid.

All of this is regulated by a microcontroller-based system with feedback loops and a battery management system (BMS). A PI (Proportional-Integral) controller examines real-time current and voltage values and produces control signals to adjust the duty cycles of the converter switches. Current sensors are used to read the actual current being drawn from or supplied to the battery and compare it with a reference set current. The PI controller drives the switching action by utilising the error signal, allowing for accurate current regulation and preventing overcharge or deep discharge. The battery state of charge (SOC) is continuously monitored, and logical conditions are established to determine when switching between Vehicle-to-Grid (V2G) and Grid-to-

Vehicle (G2V) modes will occur. For instance, if the SOC is less than 60%, the system deactivates V2G operation and charges only. If the SOC is greater than a specified threshold 80%, the system activates V2G operation.

4. Simulation Results and Discussion

The simulation relies on modeling a bi-directional wireless power transfer system using MATLAB/Simulink, which supports both Grid-to-Vehicle (G2V) and Vehicle-to-Grid (V2G) scenarios.

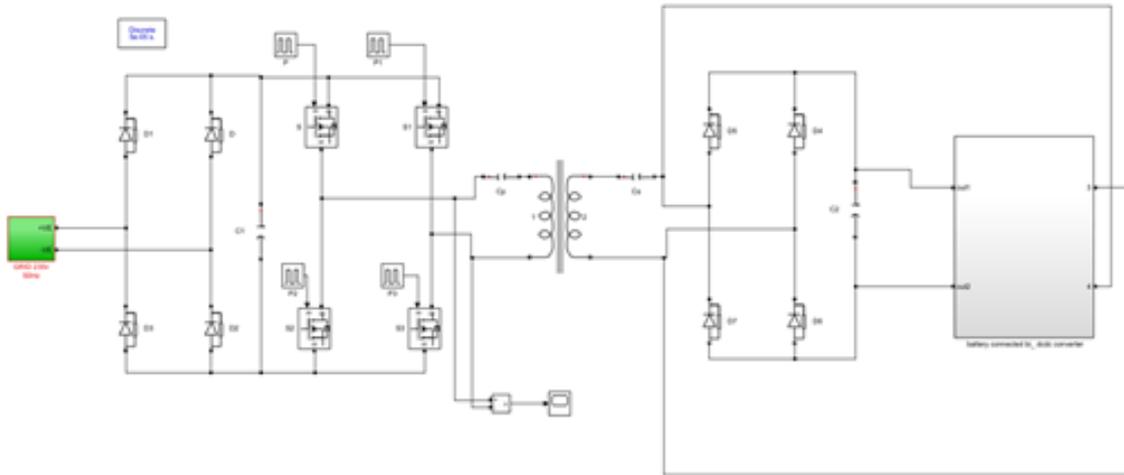


Figure 1: Proposed simulation of grid to vehicle (G2V)

It starts with DC power, which is converted to high-frequency AC using an inverter (Inverter A), thereby exciting the primary coil (Figure 1). In inductive coupling, energy is transferred wirelessly into the second coil, converted to DC, and utilised to charge a battery using a bidirectional DC-DC converter in buck mode.

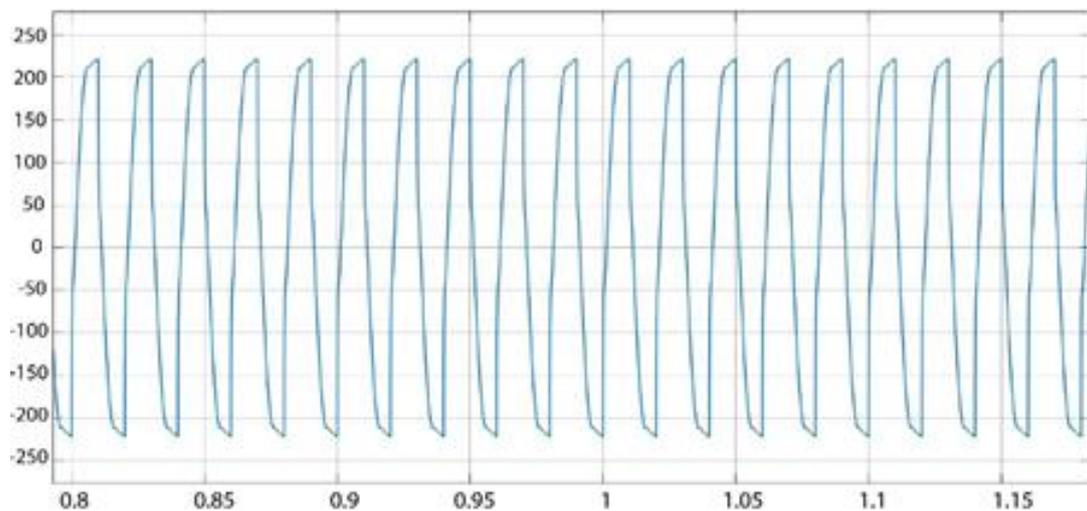


Figure 2: Output of inverter A (G2V)

When the battery contains surplus energy, in V2G mode, the converter runs in boost mode, injecting DC power back into the coil. It gets converted by Inverter B again to AC for return to the grid. A high-tech PI controller control system constantly monitors voltage, current, and SOC of the battery and decides on charge or discharge. Waveforms and readings confirm power efficiency and switching direction. This is Inverter A (Figure 2) output waveform in Grid-to-Vehicle (G2V) operation. In this operation, DC power from the grid-side DC source is transformed into high-frequency AC through the application of a high-frequency full-bridge inverter, with an inverter switching speed of 85 kHz. The output waveform generally is a square wave or PWM signal, which is required to ensure effective inductive coupling in the wireless power transfer system. The AC of high

frequency provides low magnetic coupling core losses, allowing efficient power transfer from the primary coil to the secondary side.

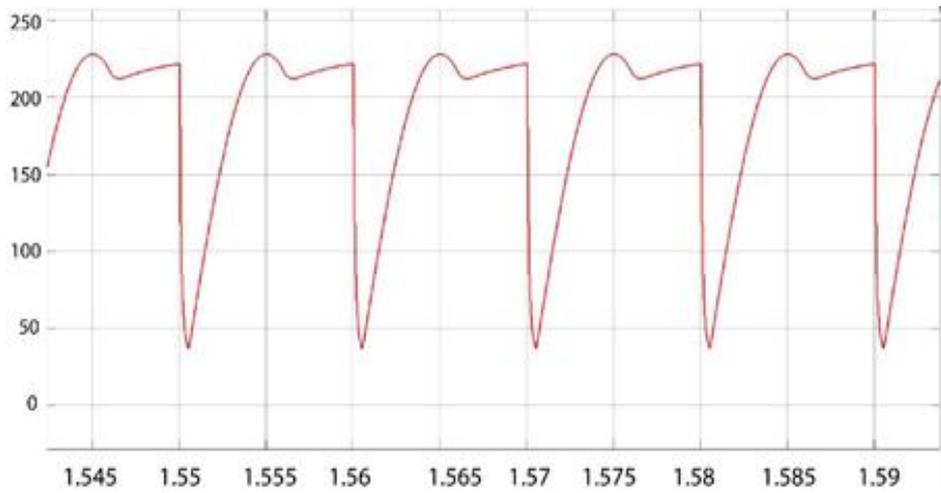


Figure 3: Output of the bridge rectifier

This waveform is the rectified waveform (Figure 3) obtained after getting the high-frequency AC from the receiver coil. The bridge rectifier on the receiver side again converts the induced AC voltage into DC voltage. The waveform will typically be a pulsating DC with some amount of ripple, depending on the filtering components used. A capacitor or an LC filter is used to smooth out this waveform, providing a stable DC output that charges the 40-kWh battery through a DC-DC converter. This output verifies the successful wireless power transfer between the transmitter and receiver.

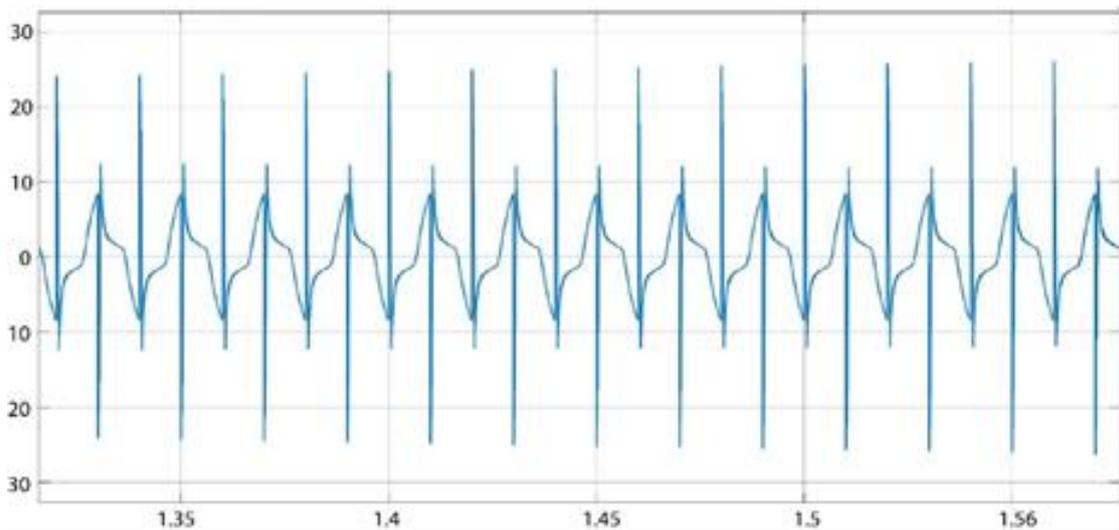


Figure 4: Output of inverter B (V2G)

This waveform is the output of Inverter B (Figure 4) in Vehicle-to-Grid (V2G) mode. In this scenario, the stored energy in the EV battery is returned to the grid. The bidirectional DC-DC converter upconverts the battery voltage, and Inverter B converts it into AC, making it compatible with the grid. The resulting wave shape is once again a high-frequency AC voltage signal, identical in form to Inverter A but in the opposite direction of power flow. This output proves the bidirectionality of the system and demonstrates that power can be driven back into the grid under controlled conditions (Figure 5).

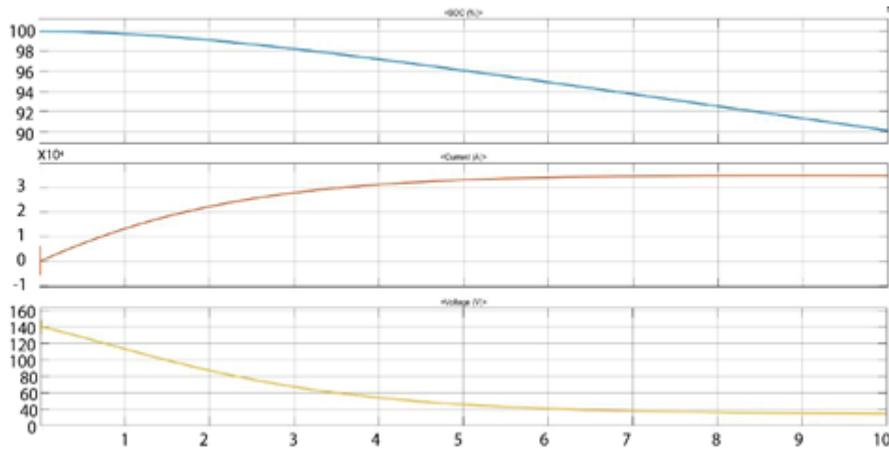


Figure 5: Battery SOC, current, and voltage

5. Hardware Implementation

The main objective is to wirelessly charge an EV battery from a battery storage or power grid using inductive coupling and enabling reverse energy transfer in V2G modes of operation (Figure 6).

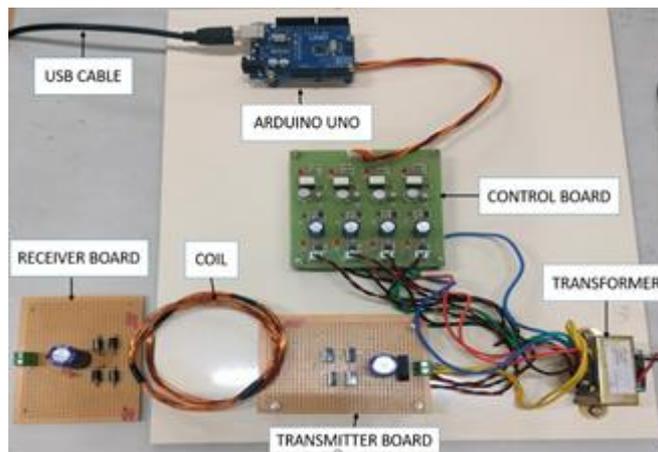


Figure 6: Proposed model of wireless power transmission

The system aims to eliminate the need for mechanical connectors by utilising resonant inductive coupling, thereby enhancing overall system performance and security. It also aspires to control bidirectional power flow through embedded control systems and smart power electronics (Figure 7).

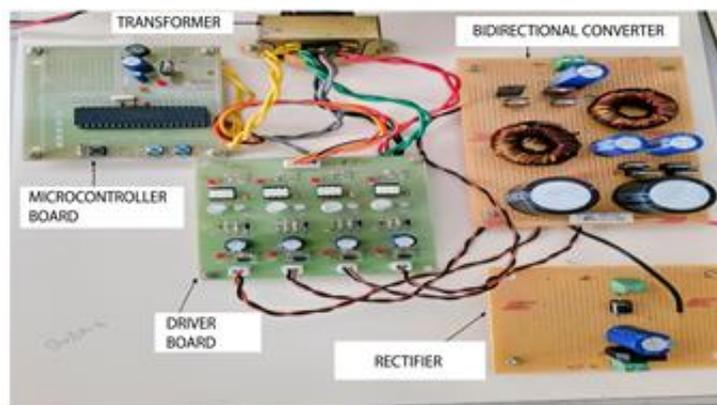


Figure 7: Proposed model of bidirectional power flow

5.1. Transformer and Power Source Stage

The process starts with an AC power source (grid), which is stepped down in voltage by a transformer. The transformer provides electrical isolation and reduces the AC voltage to a level suitable for further processing. The transformer output feeds into a rectifier circuit.

5.2. Rectifier Circuit

The rectifier circuit accepts the AC voltage from the transformer and converts it into a DC voltage. The DC voltage is fed as an input to the transmitter side of the system. Smoothing capacitors ensure a ripple-free DC output, essential for the proper operation of the following circuits.

5.3. Bidirectional Converter

A bidirectional DC-DC converter is a crucial component that controls power flow in both directions—charging (from the grid to the car) or discharging (from the car to the grid) (Figure 7). The converter converts voltage levels, controls the flow of current, and exhibits high efficiency in power transfer. In forward operation mode, the converter lowers the DC voltage of the grid level to a level sufficient for wireless transmission and EV battery charging. In reverse operation mode, the converter increases the battery voltage to give back to the grid at V2G mode.

5.4. Transmitter and Receiver Boards

The bidirectional converter supplies power to the transmitter board, which uses switching devices (for example, MOSFETs) activated by a high-frequency signal to generate an alternating magnetic field. The signal is modulated at a resonant frequency to achieve maximum inductive coupling efficiency. The alternating field induces a voltage across the receiver coil at a distance (typically 30 cm), perpendicular to the transmitter coil. The incoming AC signal is converted to DC again by the receiver board using a rectifier and regulated to charge the battery.

5.5. Coil Assembly for Inductive Coupling

Inductive power transfer is employed with a circular copper coil on both the transmitter and receiver sides. The coils create a loosely coupled transformer based on mutual inductance. The frequency of the coils for operation is optimised at a resonant frequency through parallel or series LC compensation, resulting in the lowest reactive losses and highest efficiency.

5.6. Microcontroller and Arduino UNO

Control is achieved through a microcontroller and an Arduino Uno board, which manages power flow, switch transitions for the converter and driver boards, and system parameter monitoring. It controls pulse-width modulation (PWM) signals to drive converters and senses battery voltage, current, and state of charge (SOC).

5.7. Control Board and Driver Circuit

The control board passes the signals to the Arduino, which in turn toggles PWM signals to the power electronics. It also controls the direction of the current flow based on the operation mode (discharging or charging). The driver board translates the low-level PWM signals from the microcontroller into the appropriate gate drive levels for the switching devices.

5.8. Grid-to-Vehicle (G2V) Mode

In this, grid AC power is stepped down in voltage and converted to DC by the bidirectional converter. The power is wirelessly transmitted through the coil assembly to the receiver side and is ultimately regulated to charge the EV battery. The control scheme ensures that the battery receives the proper voltage and current by dynamically regulating the duty cycles of the converter's switches.

5.9. Vehicle-to-Grid (V2G) Mode

As the grid requires power and the EV holds enough charge, the system operates in reverse mode. DC power is supplied to the receiver board by the battery and then transferred to the transmitter through inductive coupling. The voltage is transformed to grid levels by the bidirectional converter, and the energy is stored or consumed locally by the transformer and inverter stage in the case of deployment.

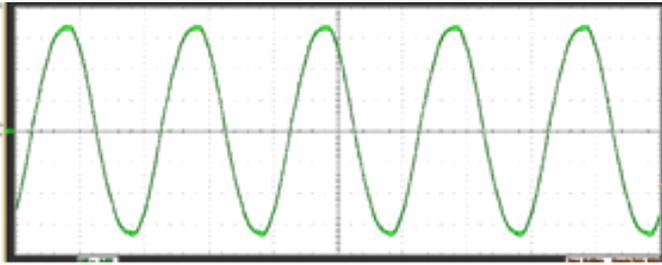


Figure 8: Input supply (AC source)

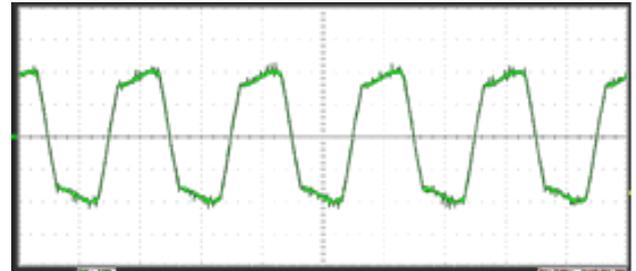


Figure 9: Full-wave bridge rectifier output

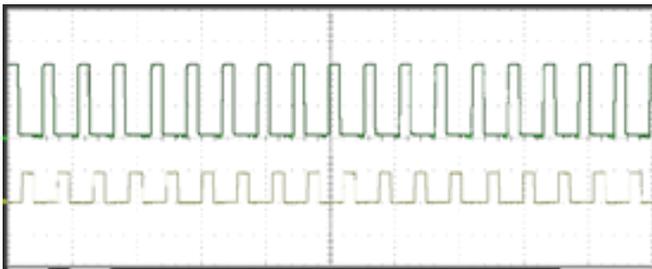


Figure 10: Inverter output



Figure 11: Wireless charging secondary side output

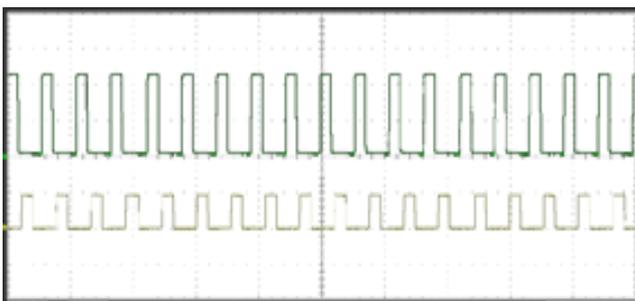


Figure 12: Gate pulse for MOSFET

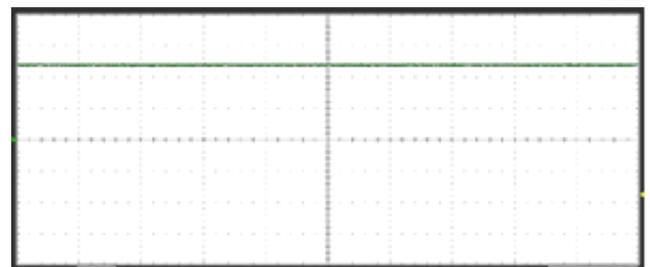


Figure 13: Output DC voltage from the grid to the vehicle

6. Results and Discussions

The bidirectional V2G and wireless power transfer system hardware demonstrates that efficient energy exchange from the grid to an electric vehicle can be applied practically, utilising resonant inductive coupling and power electronic control. The AC input voltage supplied by the grid is stepped down to 12V using a transformer (Figure 8), and the sinusoidal waveform on the DSO serves as an indicator of safe transformer operation and a stable supply for subsequent stages. The full-wave bridge rectifier rectifies the AC to DC, and the waveform (Figure 9) supplied to the primary coil of the transformer depicts a high-frequency modulated signal that is responsible for generating the alternating magnetic field. The waveform of the inverter output indicates a 20kHz PWM switching action (Figure 10) with voltage spikes of up to 12V, which verifies high-frequency power transfer and resonant operational capability. The secondary coil at the receiver's end taps the magnetic energy and supplies an induced AC voltage of 12V (Figure 11), which is rectified and current-limited before being securely charged to the battery. The PIC microcontroller produces a stable 5V PWM (Figure 12) output for powering MOSFET gates, with sensed gate pulses providing sufficient high-speed switching for bidirectional operation.

The bidirectional converter responds to step-up operation, providing a 12V output from a 12V input for V2G mode and vice versa for G2V mode. The result in grid-to-vehicle mode was a constant 12V DC (Figure 13), indicating a constant charging condition of the battery with negligible ripple or disturbance. Additionally, a transmission distance of 30 cm was demonstrated, exceeding the entire desired range of 15 cm for IPT systems. As the transmitters and receiver coils were kept at a distance of 30 cm from one another, the system produced an output of 12V and 3A DC as the output voltage and output current, respectively. The waveforms overall ensure that all stages, ranging from the AC supply to rectification, high-frequency conversion, wireless

transfer, and final battery output, are functioning correctly and effectively. The overall setup confirms the effective integration of power electronics, control systems, and wireless power transmission in a usable and scalable electric vehicle discharging and charging system. Table 1 presents a comparison chart for the G2V and V2G systems.

Table 1: Hardware comparison for G2V and V2G

Feature	Hardware 1	Hardware 2
Direction of Power Flow	Unidirectional (G2V only)	Bidirectional (G2V and V2G)
Control System	Basic switching	Closed-loop with PI controller
Converter Type	One-way rectifier & buck converter	Bidirectional buck-boost converter
Battery Management	Simple load	SOC-aware, intelligent switching
Simulation Scope	Demonstration of the IPT concept	Real-world EV charging and grid integration model

7. Conclusion

The construction of a bidirectional wireless power transfer (BWPT) system for charging an electric vehicle (EV) in a vehicle-to-grid (V2G) setting is a promising achievement towards sustainable transport and smart grid technologies. The hardware prototype, comprising the transmitter board, receiver board, coil assembly, bidirectional converter, microcontroller unit, control board, driver circuit, transformer, and rectifier, was found to guarantee efficient contactless energy transfer effectively. The system also operates in both charge and discharge modes, hence allowing the electric vehicle not only to receive electricity from the grid but also to supply charged energy to the grid during peak load. The switching and signal processing are performed using a flexible control platform, consisting of an Arduino UNO and a microcontroller board, thereby facilitating the synchronisation of appropriate power electronic components. The bidirectional converter controls voltage and direction of power flow, while the driver and rectifier circuits assure stable power conversion and supply.

Inductive power transmission via the coil eliminates the need for mechanical connectors, thereby increasing safety, reliability, and convenience in EV charging systems. The wireless configuration also minimises wear and tear and possible risks with plug-in systems. Additionally, the inclusion of the V2G concept enhances grid stability and efficiency, with the potential for distributed energy storage from EVs to support grid stabilisation. The system designed is a worthwhile model for future intelligent EV infrastructure, providing a scalable and efficient wireless power transfer that will resonate with the world's shift towards cleaner energy and smart transportation systems. Additionally, a transmission distance of 30 cm was also achieved, exceeding the total desired range of 15 cm for IPT systems. With the transmitters and receiver coils separated by a distance of 30 cm, the system produced an output voltage of 12V and an output current of 3A DC.

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Data Availability Statement: The study utilizes a dataset that contains information on bidirectional wireless power transfer for electric vehicle charging in V2G and G2V systems. The dataset is available upon reasonable request from the corresponding authors.

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Conflicts of Interest Statement: The authors collectively declare that there are no conflicts of interest associated with this study. All citations and references have been appropriately acknowledged.

Ethics and Consent Statement: The authors confirm that informed consent was obtained from the relevant organization and participants during data collection, with ethical approval and participant consent duly received.

References

1. A. Jamaluddin, F. A. Perdana, A. Supriyanto, A. Purwanto, I. Inayati, and M. Nizam, "Development of Wireless Battery Monitoring for electric vehicle," in *2014 International Conference on Electrical Engineering and Computer Science (ICEECS)*, Kuta, Bali, Indonesia, 2014.
2. A. Kurs, A. Karalis, R. Moffatt, J. D. Joannopoulos, P. Fisher, and M. Soljačić, "Wireless power transfer via strongly coupled magnetic resonances," *Science*, vol. 317, no. 5834, pp. 83–86, 2007.

3. B. Esteban, M. Sid-Ahmed, and N. C. Kar, "A comparative study of power supply architectures in wireless EV charging systems," *IEEE Trans. Power Electron.*, vol. 30, no. 11, pp. 6408–6422, 2015.
4. H. Fnato, Y. Chiku, and K. Harakawa, "Wireless power distribution with capacitive coupling excited by switched mode active negative capacitor," in *2010 International Conference on Electrical Machines and Systems, ICEMS2010*, Incheon, South Korea, 2010.
5. M. Madadi, M. Jazaeri, and H. Molla-Ahmadian, "Design and implementation of an ultra-high gain, soft-switching, bidirectional dc-dc converter with high efficiency," *e-Prime - Advances in Electrical Engineering, Electronics and Energy*, vol. 12, no. 6, pp. 1-9, 2025.
6. M. Venkatesan, N. Moorthi, P. Kacor, and M. Vrzala, "Bidirectional wireless power transfer: Bridging electric vehicles and the grid through converter analysis, coil topologies, and communication protocol review," *Results Eng.*, vol. 25, no. 3, pp. 1-28, 2025.
7. P. Barman, L. Dutta, S. Bordoloi, A. Kalita, P. Buragohain, S. Bharali, and B. Azzopardi, "Renewable energy integration with electric vehicle technology: A review of the existing smart charging approaches," *Renew. Sustain. Energy Rev.*, vol. 183, no. 9, pp. 1-15, 2023.
8. S. Li and C. C. Mi, "Wireless power transfer for electric vehicle applications," *IEEE J. Emerg. Sel. Top. Power Electron.*, vol. 3, no. 1, pp. 4–17, 2015.
9. U. K. Madawala and D. J. Thrimawithana, "A bidirectional inductive power interface for electric vehicles in V2G systems," *IEEE Trans. Ind. Electron.*, vol. 58, no. 10, pp. 4789–4796, 2011.
10. V. Funde, M. Gulpude, S. Latelwar, V. Channawar, and S. Khubalkar, "Design and implementation of microcontroller based smart battery management system," in *2024 Second International Conference on Smart Technologies for Power and Renewable Energy (SPE Con)*, Ernakulam, Kerala, India, 2024.