

Wireless Power Transfer Efficacy: A Study on Efficiency, Applications, and Future Scope

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Abstract

Wireless Power Transfer (WPT) is a modern technology that transfers electrical energy from one device to another without using physical wires. This technology is becoming popular in mobile charging, electric vehicles, medical devices, and smart electronics. The main purpose of this research paper is to study the efficacy and efficiency of wireless power transfer systems. The paper explains the working principle, advantages, limitations, and real-life applications of WPT. It also discusses different methods such as inductive coupling and resonant coupling. The study concludes that wireless power transfer can improve convenience and reduce cable dependency, but efficiency and distance limitations still need improvement. Future developments may help WPT become more reliable and widely used in daily life.

Keywords

Wireless Power Transfer, Efficiency, Inductive Coupling, Resonant Coupling, Electric Vehicles, Wireless Charging, Energy Transfer, Smart Devices, Modern Technology, Power Transmission

Introduction

Wireless Power Transfer (WPT) is a technology that allows electrical energy to be transferred from a power source to an electrical device without using connecting wires. The idea of wireless electricity was first introduced by Nikola Tesla many years ago. Today, this technology is used in smartphones, smartwatches, electric toothbrushes, medical implants, and electric vehicles.

Traditional charging systems require cables and connectors, which may get damaged over time. Wireless charging provides a safer, cleaner, and more convenient solution. WPT mainly works on electromagnetic fields to transfer energy between two coils. The transmitter coil generates a magnetic field, and the receiver coil converts it back into electrical energy.

There are different types of wireless power transfer methods:

- Inductive Coupling
- Resonant Inductive Coupling
- Microwave Power Transfer

- **Laser Power Transfer**

Among these, inductive coupling is the most commonly used method in mobile phone charging systems.

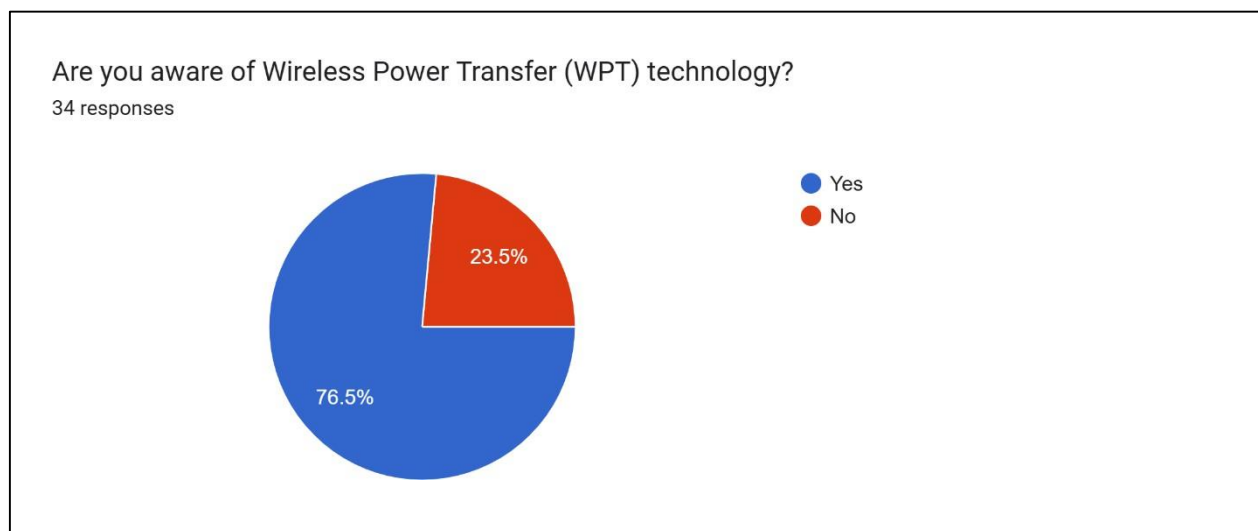
The efficacy of wireless power transfer depends on several factors such as distance, coil alignment, frequency, and environmental conditions. Although WPT offers many advantages, it also faces challenges like energy loss, heating issues, and limited transmission range.

In recent years, industries and researchers have focused on improving the efficiency and reliability of wireless charging systems. As technology continues to grow, wireless power transfer may become an important part of future smart cities and advanced transportation systems.

Objectives

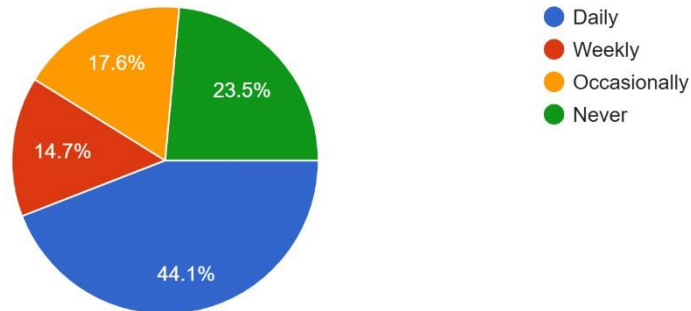
1. To study the basic concept and working of wireless power transfer.
2. To understand different methods used in WPT systems.
3. To analyze the efficiency and efficacy of wireless power transfer technology.
4. To identify the advantages and limitations of wireless charging systems.
5. To study real-world applications of wireless power transfer.
6. To explore the future scope and development of WPT technology.

Data Collection



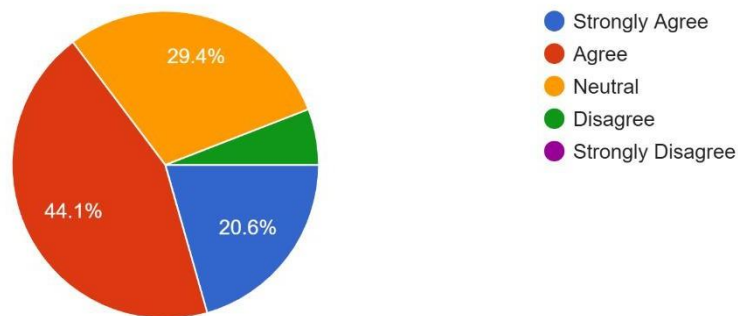
How often do you use wireless charging technology?

34 responses



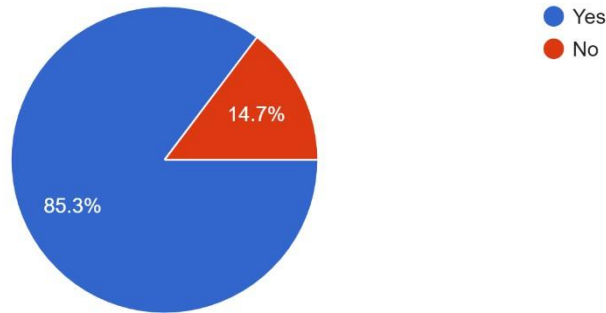
Do you think Wireless Power Transfer is more convenient than wired charging?

34 responses



Should Wireless Power Transfer be widely implemented in Electric Vehicles (EVs)?

34 responses



Hypothesis

Chi-Square Test

1. Should Wireless Power Transfer be widely implemented in Electric Vehicles (EVs)?

Sr. No.	Options	O _i	E _i	O _i -E _i	(O _i -E _i) ²	(O _i -E _i) ² /E _i
1	Yes	36	25	11	121	4.84
2	No	14	25	-11	121	4.84
Total		50				9.68

$X^2 = 9.68$, Degree of Freedom = 3.841

$3.841 < 9.68$ (DOF < X^2)

2. Do you use AI study assistants (such as ChatGPT, Gemini, or Microsoft Copilot) for your studies?

Sr. No.	Options	O _i	E _i	O _i -E _i	(O _i -E _i) ²	(O _i -E _i) ² /E _i
1	Yes	28	25	3	9	0.36
2	No	22	25	-3	9	0.36

Total		50				0.72
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$X^2 = 0.72$, Degree of Freedom = 3.841 $3.841 > 0.72$ (DOF > X^2)

Conclusion

Wireless Power Transfer is an innovative and useful technology that can reduce the dependency on physical wires and cables. It provides convenience, safety, and flexibility in many electronic applications. The study shows that WPT systems are highly effective for short-distance charging applications such as smartphones and wearable devices. It also has strong future potential in electric vehicles, healthcare equipment, and industrial automation.

However, some challenges still exist, including energy loss, high implementation cost, and limited transmission distance. Improving efficiency and reducing power loss are important areas for future research. With continuous advancements in technology, wireless power transfer can become faster, safer, and more efficient in the coming years.

Overall, wireless power transfer has the potential to transform the future of energy transmission and smart electronic systems.

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