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Review Paper on Wireless Power Transfer

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ABSTRACT

Today we live in a fast changing world. In present modern era power is very important role in our live system. The purpose of this paper practically implement concept of power transmission without wire. Wireless Power Transmission through inductive coupling is one of the new emerging technologies that will bring tremendous change in human life. Wireless power transfer is one of the simplest and inexpensive ways of charging as it eliminate the use of conventional copper cables and current carrying wires. Using inductive coupling concept an alternating current in transmitter coil generates a magnetic field which induces a voltage in the receiver coil. This voltage can be used to power a mobile device or charge a battery etc.

KEYWORDS: *Wireless Power Transmission, Inductive Coupling*

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1. INTRODUCTION

Wireless power transmission (WPT) has emerged as a promising solution to address the limitations of traditional wired power delivery systems. This paper provides a comprehensive overview of WPT, including its principles, technologies and applications. We discuss various WPT techniques, such as magnetic resonance coupling, inductive coupling, and microwave power transmission, Using inductive coupling concept an alternating current in transmitter coil generates a magnetic field which induces a voltage in the receiver coil. This voltage can we used to power a mobile device or charge a battery etc.

One of the major drawbacks in wired power system is the losses taking place during the transmission and distribution of electrical power. The approximated amount of power loss during distribution and transmission is 26%. The main reason for this power loss is the resistance of wires that are used for grid [1]. We can improve the efficiency of power distribution and transmission to a little extent by using underground cables and high strength overhead conductors (composite overhead conductors) that employ high temperature super conductor. However, the transmission efficiency is still less (inefficient). As per the World Resources Institution (WRI), the percentage power loss during transmission and distribution in India because of electricity grid is around 27%.According to some Indian Government Agencies the percentage power loss is 30%-40% and more than 40%. This attributes to theft and technical losses. Power transmission using wired way doesn't provide portability for the devices or instruments consuming power [1]. Wireless Power Transfer (WPT) allows us to use air as a medium for the transmission of electricity without using any kind of current carrying conductors. It can deliver electricity or power from an AC source to compatible devices or batteries without using wire or any kind of physical connectors. It can also used to charge mobile cell phones, tablets, electric cars or bikes, drones, and transportation equipment's. It might also allow us to transmit the power gathered by arrays of solar panels wirelessly. Wireless transmission of power[3] is emerging as a trend to transmit power and charge various devices without any wired medium.

2. Overview of WPT

Maxwell's equations mathematically predict that electromagnetic waves can propagate in space as a carrier of energy, which has led to the revolutionary development of wireless communication and thus changed modern society in numerous ways. Based on

the same physical principle, when compared to the transfer of digital bites in wireless communication, a much larger amount of energy can also be transferred wirelessly over a long distance. Nikola Tesla[2] is a pioneer of WPT. Many of his discoveries have become the basis of today's WPT research. In the late 19th century, the proposed "Tesla Coil" served as an early demonstration of WPT.

3. Types of Wireless Power Transmission Technique:

WPT can be realized by inductive power transfer (IPT), capacitive power transfer (CPT), microwave power transfer (MPT), laser power transfer (LPT), and acoustic power transfer (APT), respectively.

1) IPT – IPT uses coupling coils to transmit power over a relatively short distance [see Figure 1]. The transmitting coil is driven by alternating current to generate an alternating magnetic field in the surrounding area. The receiving coil placed near the transmitting coil then induces an alternating current. IPT is currently the most widely-used WPT technology, suitable for various power levels. Its effective power transfer distance is directly limited by the size of the coupling coils.

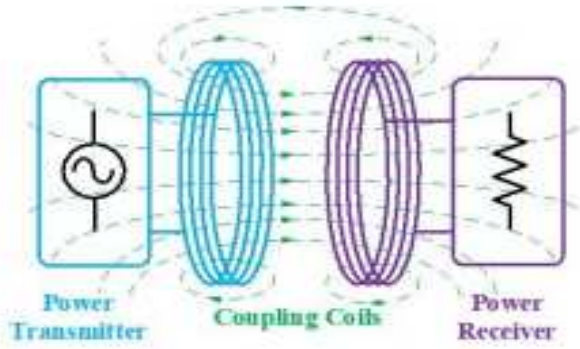

Figure1

2) CPT – CPT normally uses two sets of coupled plates to transfer power through a certain distance. Compared to IPT, the power transfer distance of CPT is relatively short. Both IPT and CPT can achieve relatively high efficiency (≥90%) at high power levels (up to kilowatt).CPT uses electric field coupling and therefore can transfer power through metal barriers. Meanwhile, there is a safety risk due to the electric field coupling.

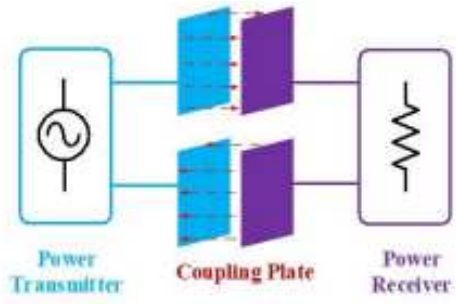

Figure 2

3) MPT – Microwaves are emitted from the antenna into free space and propagate over a long distance (i.e., many times the size of the antenna). The receiving antenna collects and converts microwave energy. Because MPT has an omni directional characteristic, efficiency is usually significantly lower than that of IPT. In commercial applications, its output power is also small to avoid radiation level that may be hazardous to the human body or interfere other electronic devices

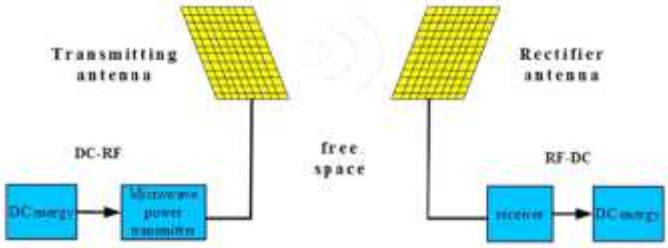

Figure 3

4) LPT –The laser emitter generates a monochromatic beam. Then, a set of optics is used to shape the laser beam and direct it to a remote photovoltaic (PV) receiver through a beam guide/director. The PV cells that match the laser wavelength and beam intensity convert the laser back to electrical energy. For most research work, the wavelength is between 532 and 1060 nm. Note that the most efficient lasers work at near-infrared wavelengths in the retinal hazard region.

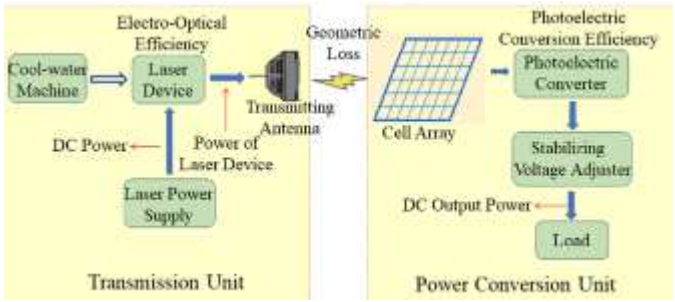

Figure 4

5) APT – APT is a relatively new form of WPT that uses sound waves to transfer energy wirelessly, while all other WPT technologies rely on electromagnetic field/waves. A medium is needed between the transmitter and receiver to convey sound waves. This technology allows power to be transferred through metal. In most research, the frequency of sound waves is between 0.5 and 2.25 MHz. APT operating frequency should be away from the resonance frequency of the ambient objects.

4. Comparison of Different Technologies

Technology	Range	Directivity	Frequency	Current/Future Application
Inductive coupling	short	Low	Hz-MHz	Electric Tooth brush and razor battery charging, Induction stovetops and Industrial Heaters
Capacitive coupling	short	Low	KHz-MHz	Charging portable devices, Smartcards, Biomedical Implants
Micro Waves	Long	High	GHz	Solar Power satellite, powering drone aircraft, charging wireless devices
Light	Long	High	>=THz	Charging portable devices, powering drone aircraft, powering space elevator climbers

Table 1

5. Block Diagram of Wireless Power Transfer System

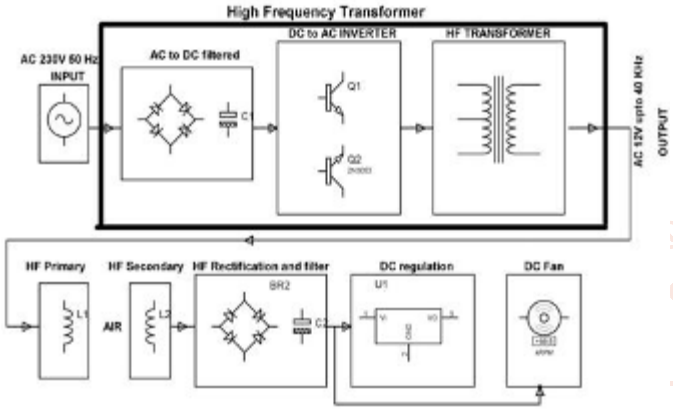

Figure5

Wireless Power Transfer Systems (WPTSs) are designed as two sections. One is a transmitting section and the other is a receiving section. The transmitting section transfers power to the receiving section by using the basic principle of resonating coil and the technology is based on magnetic field. Transmitting system is supplied from the grid as AC input. This AC power is converted to controllable DC current by the rectifier and comprises a Power Factor Correction (PFC) stage which is used to reduce losses. Then there will be a High frequency inverter which is used to convert high frequency DC to high frequency AC. This HF AC power is given to high frequency transformer

The HF transformer delivers excitation current to a series-tuned primary coil of sufficient magnitude to magnetize the air volume between it and the coil mounted secondary. The HF transformer is used for electrical isolation. The primary and secondary coils are kept at a distance and the mutual inductance is used for transfer of power. Voltage induced at the secondary is rectified, filtered, and delivered to the load directly from the WPT rectifier. WPT applications may require inclusion of an HF transformer to provide electrical isolation of the WPT

6. Model:

The main concept of this project is to design a device for the concept of wireless power transfer to eliminate the use conventional copper cables and also current carrying wires.

This project is built upon using a circuit which converts AC 230V 50Hz to AC 12V, High frequency (HF). The output is fed to a tuned coil shaping as main of an air core transformer. The minor coil develops a voltage of HF 12volt.

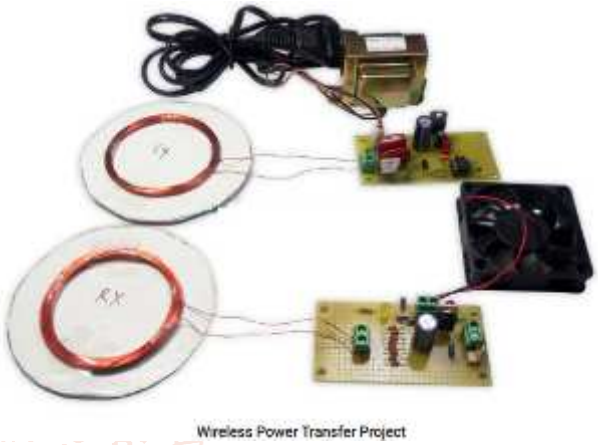

Figure 6

Thus the power transfer can be done by the primary to the secondary that is divided with 3cm distance. So the transfer could be seen as the primary transmits and the secondary receives the power to run a load.

7. Merits of WPT:

1. WPT system completely reduces existing high-tension power transmission cables, substations and towers between the consumers and generating station.
2. The cost of the distribution and transmission become less.
3. The cost of the electrical energy to the consumers also reduces.
4. The power could be transmitted to places to which the wired transmission is not possible.

Figure 7

8. Application Area

1. Applications in Smart Homes and Buildings

WPT technology has been widely used in consumer electronics devices such as smart phones, earbuds, and various wearable devices. The WPT market is growing rapidly every year, and its applications have been widely used in many household appliances: coffee machines, robot vacuum cleaners, electric kettles, and many other examples. WPT can be widely used in kitchens and bathrooms where electricity and water coexist. WPT enables these devices to have a closed structure, making them more waterproof and dustproof and eliminating the risk of electric shock. Following Figure. 8 shows some WPT applications in kitchen appliances, including ovens, kettles, blenders, etc. These appliances can be charged by simply placing them on a transmitter installed beneath the kitchen countertops, which improves convenience and safety.

Figure 8.Concept of cordless kitchen: Equipping WPT into various kitchen appliances

2. Consumer electronics:

Products like wireless charging pads and wireless charging tables have begun to take place in market.

Figure 9

3. Automotive:

A wireless charger for electric vehicles has been developed and commercialized. In some production vehicles, in-car wireless charging pads have started to be offered as an option.

4. Medical:

There are studies about the charging of medical products such as pacemaker while inside the body.

5. Industry

Work is being carried out on the electrical supply of equipment found in dirty and difficult to connect environments.

6. Energy:

The solar power plant is installed on the moon and the generated energy is sent to the earth using wireless power transmission technology as a future project.

In addition, companies like Texas Instruments, Linear Technology have customized chips for wireless charging circuits.

9. Result

The wireless power transmission technology that Tesla inherited to the world more than 100 years ago has recently been started to rediscover. It is obvious that this technology can be used effectively in the near future, since it is thought that everything can be changed in the world of mobilization.

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