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INTRODUCTION AND OVERVIEW ON WIRELESS TRANSFER OF ELECTRIC ENERGY

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Abstract: In this paper we have introduced a technology in which we can transfer the electric energy using wireless technology. Also we have a short overview on wireless transfer of electricity. Using self-resonant coils in a strongly coupled regime, the team experimentally demonstrated efficient non-radiative power transfer over distances up to 8 times the radius of the coils. They were able to transfer 60 watts with ~ 40% efficiency over distances in excess of 2 meters. Also we refer different types of antennas using which we implement this technology.

Keywords: Electric Energy, Wireless Transfer

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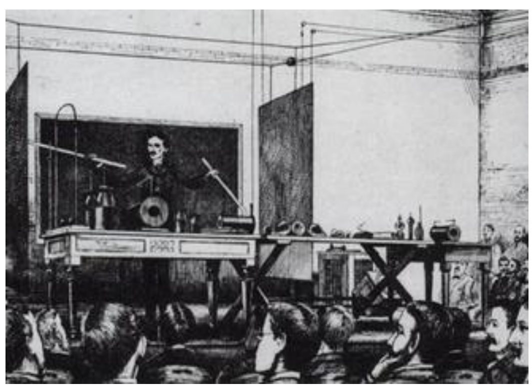
INTRODUCTION

In the 1890's, famous scientist and engineer Nikola Tesla demonstrated the wireless transmission of electrical energy, based on the principle of electric conductivity [1]. This was achieved using big, coupled electromagnetic resonators able to generate very large electric fields, which were meant to propagate most likely either via conduction through the ionosphere or through the intermediate coupling to the Earth's charge resonances. Tesla concluded that the earth is an excellent electrical conductor, and an electric current can be made to propagate undiminished for distances of thousands of miles. It was also found that the earth's natural electrical charge can be made to oscillate, "by impressing upon it [very low frequency] current waves of certain lengths, definitely related to its diameter." Based upon these principles, Tesla envisioned the development of a wireless-powered world. Due to financial problems, this idea was abandoned and copper cables became the basis for modern electricity infrastructure. In 1964, William C Brown demonstrated a micro wave powered model helicopter.



Tesla demonstrating wireless transfer of electricity in a lecture at Columbia College. New York in 1981. The two metal sheets are connected to his Tesla coil oscillator, which lies high radio frequency oscillating voltage. The oscillating electric field between the sheets ionizes the low pressure gas in the two long Geissler Tubes he is holding, causing them to glow by fluorescence, similar to neon lights.

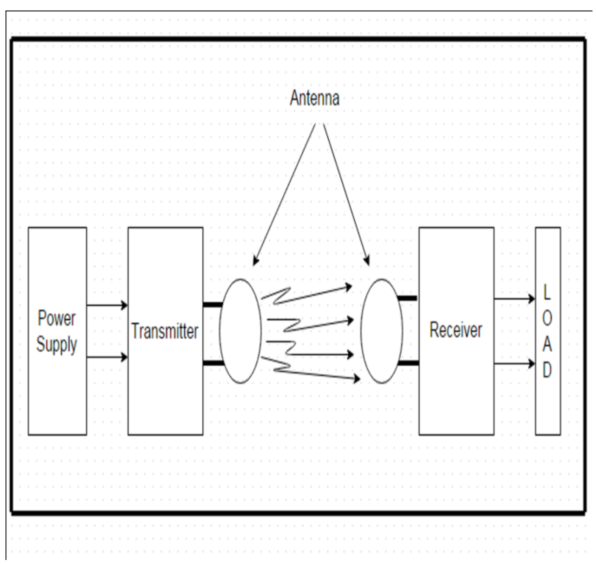
In 1975, Brown was technical director of a JPL Raytheon program that beamed 30 kW over a distance of 1 mile at 84% efficiency using microwaves.

A team of MIT physicists and students, managed by Professor Marin Soljačić, developed the theoretical basis for a novel method. for wireless electric power transfer in 2005, and authenticated their theories experimentally in 2007. They used the phenomenon of Resonant Magnetic Coupling for Ireless electric power. A 60W bulb was powered over a distance of 2 meters with 40% efficiency [1][3]. In recent times, several companies like Witricity Corp and Splashpower came into existence, that have developed technologies for charging small gadgets, such as cell phones and cameras, using electromagnetic induction.

Overview:

Generic block diagram of a wireless power system

"Wireless power transmission" is a collective term that refers to a number of different technologies for transmitting power by means of time-varying electromagnetic fields. The technologies, listed in the table below, differ in the distance over which they can transmit power efficiently, whether the transmitter must be aimed (directed) at the receiver, and in the type of electromagnetic energy they use: time varying electric fields, magnetic fields, radio waves, microwaves, or infrared or visible light waves.[4]



In general a wireless power system consists of a "transmitter" device connected to a source of power such as mains power lines, which converts the power to a time-varying electromagnetic field, and one or more "receiver" devices which receive the power and convert it back to DC or

AC electric power which is consumed by an electrical load.[1][4] In the Transmitter the input power is converted to an oscillating electromagnetic field by some type of "antenna" device. The word "antenna" is used loosely here; it may be a coil of wire which generates a magnetic field, a metal plate which generates an electric field, an antenna which radiates radio waves, or a laser which generates light. A similar antenna or coupling device in the receiver converts the oscillating fields to an electric current. An important parameter which determines the type of waves is the frequency f in hertz of the oscillations. The frequency determines the wavelength $\lambda = c/f$ of the waves which carry the energy across the gap, where c is the velocity of light.

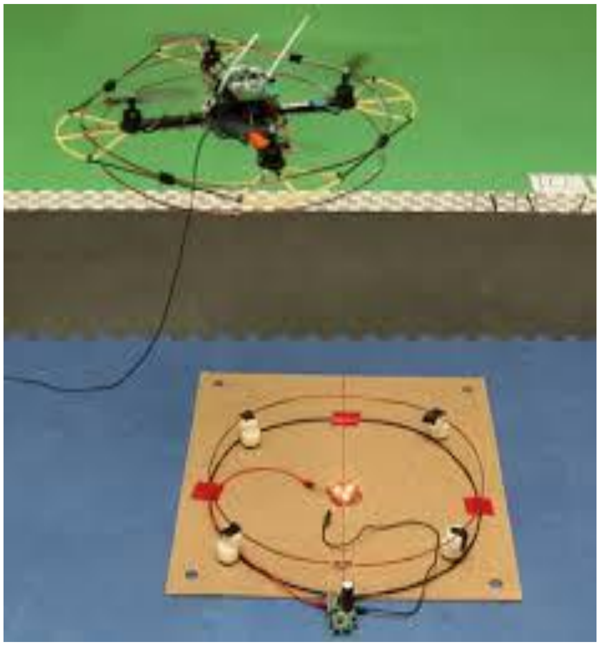
Wireless power uses much of the same fields and waves as wireless communication devices like radio,[3][6] another familiar technology which involves power transmitted without wires by electromagnetic fields, used in cell phones, radio and television broadcasting, and Wi-Fi. In radio communication the goal is the transmission of information, so the amount of power reaching the receiver is unimportant as long as it is enough that the signal to noise ratio is high enough that the information can be received intelligibly.[2][3][6] In wireless communication technologies generally only tiny amounts of power reach the receiver. By contrast, in wireless power, the amount of power received is the important thing, so the efficiency (fraction of transmitted power that is received) is the more significant parameter.[2] For this reason wireless power technologies are more limited by distance than wireless communication technologies.

These are the different wireless power technologies:[1] [4] [5] [7] [8]

Inductive coupling technology is used in the short range in between Hz-MHz and antenna devices like wire coils are used to connect transmitter and receiver, it has low directivity also applicable in Electric tooth brush and razor battery charging, induction stovetops and industrial heaters.

Resonant inductive technology is used in mid-range in between MHz-GHz and antenna devices like Tuned wire coils, lumped element resonators are used to connect transmitter and receiver, it also has low directivity and applicable in Charging portable devices (Qi, WiTricity), biomedical implants, electric vehicles, powering busses, trains, MAGLEV, RFID, smartcards.

Capacitive coupling technology is used in between kHz – MHz and antenna devices like electrodes are used to connect transmitter and receiver, has low directivity also applicable in charging portable devices, power routing in large scale integrated circuits, Smartcards. Between kHz – MHz and antenna devices like electrodes are used to connect transmitter and receiver, has low directivity also applicable in charging portable devices, power routing in large scale integrated circuits, Smartcards.



Magneto dynamic coupling technology is used in the short range in between Hz-MHz and antenna devices like rotating magnets are used to connect transmitter and receiver, it has N.A. directivity also applicable in charging electrical vehicles.

Microwaves technology is used in the long range GHz and antenna devices like parabolic dishes, phased array, rectennas are used to connect transmitter and receiver, it has high directivity also applicable in solar power satellite powering drone aircraft.

Light waves technology is used in the long range ≥THz and antenna devices like lasers, photocells, lenses and telescopes are used to connect transmitter and receiver, it has high directivity also applicable in powering drone aircraft, powering space elevator climbers.

These are the different wireless power technologies:

Sr. No.	Technology	Range of transmission	Directivity	Frequency	Antenna devices
1.	Inductive coupling	Short	Low	Hz-MHz	Wire coils
2.	Resonant inductive coupling	Mid	Low	MHz-GHz	Tuned wire coils
3.	Capacitive coupling	Short	Low	kHz-MHz	Electrodes
4.	Magneto dynamic	Short	N.A.	Hz	Rotating magnets
5.	Microwaves	Long	High	GHz	Parabolic dish
6.	Light waves	Long	High	≥THz	Lasers, telescopes, lenses, photocells

CONCLUSION:

Referring this paper we conclude that the range of transmission depends upon the size of the source coil. The distance over which power can be transmitted is 8 Times the radius of the source coil. The transmission distance is independent of the size of the receiver coil and thus, the size of the receiver coil can be reduced to such an extent that it can be embedded into various devices like cell phones, laptops, etc. However, 1 important thing to be kept in mind is that the source coil and receiver coil should have the same resonant frequency. It is not necessary for the coil to be of circular shape. It can be rectangular and can complement the aesthetical features of your house/office.

The wireless electricity concept is the boon for devices which use midrange energy. Using this concept, it is possible to eliminate society's dependency on heavy and bulky batteries.

FUTURE SCOPE:

Efficiency of the system can be improved by applying silver coating on the copper wire use for coils. This will prevent oxidation of copper and increase the quality factor. Also super conductors can be used to improve the quality factor of the system. The distance over which the transmission is possible can be increased. The only solution available presently is to increase the diameter of the source coil. The practical solution is yet to come.

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