WIRELESS ELECTRICITY (WITRICITY)

Amruta Gaikwad and Ankit Chourasia
SKN SITS, Electrical Department, Pune University, Lonavala, India.

ABSTRACT

Can we imagine the life without electrical wires? From now answer to this question is yes. The method proposed in the present paper called “Witricity” will facilitate to transfer power without using wires. The efficient midrange power can be transmitted to any device which uses that range of power by the technique used in this Witricity concept. Nowadays there is a rapid development of autonomous electronics like Laptops, Cell-phones, House-hold robots and all the above devices typically rely on chemical energy storage (Battery). As they are becoming daily needs to present generation, Wireless energy transfer would be useful for many applications as above and they need midrange energy. This is the main reason to prepare this paper. Wireless electricity or witricity is the transfer of electric energy or power over a distance without the use of wires. In order for the energy to be transferred safely coupled resonators are used. When two magnetically resonating objects at “Strongly coupled” regime tend to exchange energy efficiently by transfer of power in the non-radiating fields. This is the basic principle involved in it. By taking two coils having same magnetic resonance and one is coupled to source and other is coupled to device. So that the energy transfer is efficient even the air gap between them is high.

Keywords: Witricity, Electrical resonance, electromagnetic induction, charging algorithm, power capturing device.

http://iaeme.com/JEET/issues.asp?JType=JEET&VType=2&IType=1

1. INTRODUCTION

Wireless electricity or witricity is the transfer of electric energy or power over a distance without the use of wires. In our present electricity generation system we waste more than half of its resources. Especially the transmission and distribution losses are the main concern of the present power technology. Much of this power is wasted during transmission from power plant generators to the consumer. The resistance of the wire used in the electrical grid distribution system causes a loss of 26-30% of the energy generated. This loss implies that our present system of electrical distribution is only 70-74% efficient. We have to think of alternate state-of-art technology to transmit and distribute the electricity. Nowadays global scenario has been changed a lot and there are tremendous development in every field. If we don’t keep pace with the development of new power technology we have to face a decreasing trend in the development of power sector. The transmission of power without wires may be one noble alternative for electricity transmission.
2. ORIGINATION
Wireless power transmission is not a new idea. Nickolas Tesla demonstrated transmission of electrical energy without wires in early 19th century. Tesla used electromagnetic induction systems. William C Brown demonstrated a micro wave powered model helicopter in 1964. This receives all the power needed for flight from a micro wave beam. In 1975 Bill Brown transmitted 30kW power over a distance of 1 mile at 84% efficiency without using cables. Researchers developed several technique for moving electricity over long distance without wires.

3. PRINCIPLE OF WITRICITY
It revels the main idea of the “resonance condition” between two circuits”. A. Electrical resonance: -
Electrical resonance occurs in an electric circuit at a particular resonance frequency when the impedance between the input and output of the circuit is at a minimum (or when the transfer function is at a maximum). Often this happens when the impedance between the input and output of the circuit is almost zero and when the transfer function is close to one. Resonance of a circuit involving capacitors and inductors occurs because the collapsing magnetic field of the inductor generates an electric current in its windings that charges the capacitor, and then the discharging capacitor provides an electric current that builds the magnetic field in the inductor, and the process is repeated continually. Formula of resonance frequency:

\[ f_r = \frac{1}{2\pi\sqrt{LC}} \]

where \( f \) is the resonance frequency in hertz, \( L \) is the inductance in henries, and \( C \) is the capacitance in farads when standard SI units are used.

4. WRITRICITY MECHANISM
There are various methods of transferring electricity wirelessly, basically they are classified as:

![Diagram of types of wireless electricity transmission](http://www.iaeme.com/JEET/index.asp)

**Figure 1**

4.1. Resonant Magnetic Coupling
Magnetic coupling occurs when two objects exchange energy through their varying or oscillating magnetic fields. Resonant coupling occurs when the natural frequencies of the two objects are approximately the same.
4.2. Induction Coupling

Induction coupling occurs when an energy source has a means of transferring energy to another object. One simple example is a locomotive pulling a train car- the mechanical coupling between the two enables the locomotive to pull the train, and overcome the forces of friction and inertia that keep the train still and, the train moves. Magnetic coupling occurs when the magnetic field of one object interacts with a second object and induces an electric current in or on that object. In this way, electric energy can be transferred from a power source to the powered device. In contrast to the example of mechanical coupling given for the train, magnetic coupling does not require any physical contact between the object generating the energy and the object receiving or capturing that energy.

4.3. Microwave Transmission

Power transmission via radio waves can be made more directional, allowing longer distance power beaming, with shorter wavelengths of electromagnetic radiation, typically in the microwave range. A rectenna may be used to convert the microwave energy back into electricity. Rectenna conversion efficiencies exceeding 95% have been realized. Power beaming using microwaves has been proposed for the transmission of energy from orbiting solar power satellites to Earth and the beaming of power to spacecraft leaving orbit has been considered.

Power beaming by microwaves has the difficulty that, for most space applications, the required aperture sizes are very large due to diffraction limiting antenna directionality. For example, the
1978 NASA Study of solar power satellites required a 1-km diameter transmitting antenna and a 10 km diameter receiving rectenna for a microwave beam at 2.45 GHz. These sizes can be somewhat decreased by using shorter wavelengths, although short wavelengths may have difficulties with atmospheric absorption and beam blockage by rain or water droplets. Because of the "thinned array curse," it is not possible to make a narrower beam by combining the beams of several smaller satellites.

Figure 3 Solar satellites that could send electric energy by microwaves to a space vessel or planetary surface.

5. CONDITIONS FOR WITRICITY CHARGING

- The first condition necessary is that charging must be able to occur through physical objects. If the witricty cannot be passed through physical objects then the charging can only occur in a perfect unobstructed environment. This is not realistic because there are objects all around us that can interfere with the transmission of the energy. Research thus far has found that witricty can be transmitted through wood, gypsum wallboard, plastics, textiles, glass, brick, and concrete.
- The second condition necessary is that charging must be safe and not pose any sort of threat or safety hazard to humans or animals. Since this type of energy transfer is non-radioactive it is safe for humans and animals.
- The third condition necessary is that witricty charging must be able to provide electricity to remote objects without the use of wires. Therefore, the energy must be transferable from the transmitter to the capturing device over a certain distance.
- The fourth condition necessary is that the witricty is able to transfer a meaningful amount of energy, or else it would defeat the purpose of the energy transfer.

5.1. Distance Parameter

- Diameter of the coil should increase proportionally with the frequency of operation.
- A large diameter of source coil with a large number of turns increases the distance of the operation.
- Limitation: we cannot increase the voltage of the operation above 50 to 60 volt because it is dangerous for human body and can be caused for electric shock.

5.2. How Would be the Future with Witricty

Modern science has now made it possible to use electricity without having to plug in any wires. This concept is called witricty which seems to have a bright future in providing wireless electricity. The technology used for wireless power transmission is known as witricty. Wireless power transmission is not a new idea; Nikola Tesla proposed theories of wireless power transmission in the late 1800s and early 1900s. Tesla's work was impressive, but it did not immediately lead to wide spread practical methods for wireless power transmission. Since then many researchers have developed several techniques for moving
Wireless Electricity (Witricity)

electricity over long distances without wires. Some exist only as theories or prototypes, but others are already in use. In 2006 researchers at Massachusetts Institute of Technology led by Marine Soijacic discovered an efficient way to transfer power between coils separated by a few meters. They have dubbed this technology as witricity. Witricity is based upon coupled resonant objects. Two resonant objects of the same resonant frequency tend to exchange energy efficiently, while not interchanging the surroundings. The researchers demonstrate the ability to transfer 60W with approximately 40% efficiency over distance in excess of 2 meters. Currently the project is looking for power transmission in the range of 100watts. As witricity is in the development stage, lot of work is to be done in improving the range of power transmission and efficiency.

6. ADVANTAGES

- No need of line of sight - In witricity power transmission there is any; need of line of sight between transmitter and receiver. That is power! Transmission can be possible if there are any obstructions like wood, metal, or other devices were placed in between the transmitter and receiver.
- No need of power cables and batteries - Witricity replaces the use of power cables and batteries.
- Does not interfere with radio waves.
- Wastage of power is small - Electromagnetic waves would tunnel, they would not propagate through air to be absorbed or dissipated. So the wastage is small.
- Highly efficient than electromagnetic induction - Electromagnetic induction system can be used for wireless energy transfer only if the primary and secondary are in very close proximity. Resonant induction system is one million times as efficient as electromagnetic induction system.
- Less costly - The components of transmitter and receivers are cheaper. So this system is less costly.

7. APPLICATIONS

Witricity has a bright future in providing wireless electricity. There are no limitations in Witricity power applications. Some of the potential applications are powering of cell phones, laptops and other devices that normally run with the help of batteries or plugging in wires. Witricity applications are expected to work on the gadgets that are in close proximity to a source of wireless power, where in the gadgets charges automatically without necessarily, having to get plugged in. By the use of witricity there is no need of batteries or remembering to recharge batteries periodically. If a source is placed in each room to provide power supply to the whole house. Witricity has many medical applications. It is used for providing electric power in many commercially available medical implantable devices. Another application of this technology includes transmission of information. It would not interfere with radio waves and it is cheap and efficient.

7.1. Direct Wireless Power

When all the power adevice needs in provided wirelessly, and no batteries are required. This mode is for a device that is always used within range of its witricity power source.

Eg- industrial applications like harsh environment (drilling, mining, underwater, etc) where it is impossible to run wires., across rotating and moving joints.

7.2. Automatic Wireless Charging

When a device with rechargeable batteries charges itself while still in use or at rest, without requiring a power cord or battery replacement. This mode is for a mobile device that may be used in and out of range of its witricity power source.

Eg- Consumer electronics mobile charging, home, car, office wifi hotspots
8. LIMITATIONS OF WIRELESS ENERGY
A number of companies and academic institutions (including Intel and MIT) are involved in a race to be the first to release marketable wireless energy packages; however, there are a number of limitations to the full implementation of wireless energy transfer:

- **Size:** The copper rings which create resonance and energy are simply too big for them to be part of any wireless energy package.
- **Range:** The range of wireless energy transfer is just a few meters, which is a major hurdle.
- **Efficiency:** Wireless energy transfer ensures between 45% and 80% of the energy put in is transferred, which is much less efficient than regular wired connections.
- **Cost:** The cost of developing and implementing wireless energy networks means that it would be too expensive for the end-user to afford at this point.

9. CONCLUSION
The transmission of power without wires is not a theory or a mere possibility, it is now a reality. The electrical energy can be economically transmitted without wires to any terrestrial distance. Many researchers have established in numerous observations, experiments and measurements, qualitative and quantitative. Cell phones, game controllers, laptop computers, mobile robots, even electric vehicles capable of re-charging themselves without ever being plugged in. Flat screen TV’s and digital picture frames that hang on the wall—without enquiring a wire and plug for power. Industrial systems and medical devices made more reliable by eliminating trouble prone wiring and replaceable batteries. Witricity Corp. is working to make this future a reality, developing wireless electricity technology that will operate safely and efficiently over distances ranging from centimeters to several meters—and will deliver power ranging from mill watts to kilowatts. Wireless transmission of electricity have tremendous merits like high transmission integrity and Low Loss (90 – 97% efficient) and can be transmitted to anywhere in the globe and eliminate the need for an inefficient, costly, and capital intensive grid of cables, towers, and substations. The system would reduce the cost of electrical energy used by the consumer and get rid of the landscape of wires, cables, and transmission towers. It has negligible demerits like reactive power which was found insignificant and biologically compatible. Many countries will benefit from this service. Monthly electric utility bills from old-fashioned, fossil-fuelled, loss prone electrified wire-grid delivery services will be optional, much like “cable TV” of today. Witricity Corp.’s vision is to develop a family of wireless electric power components that will enable OEM’s in a broad range of industries and applications to make their products truly “wireless.” Wireless electric power delivered over room scale distances, and with high efficiency. Wireless electric power that is safe for people and animals. Wireless electric power—imagine no more… it’s here!

ACKNOWLEDGMENT
I would like to thanks to our guide, Ankit Chourasia, Assistant Professor of SKNSITS for their kind support and providing facility to do my research work.

REFERENCE

[1] Irg 978 picture medium 1. energeticforum.com


