

A
SEMINAR REPORT
on

WIRELESS ELECTRICITY TRANSMISSION (WITRICITY)

Submitted for partial fulfillment of award of

B.Tech Degree
in

Electrical & Electronics Engineering

SUBMITTED BY

PRASOON PURWAR

0813321059

SUBMITTED TO

MR. S VIKRAM SINGH

ASST. PROFESSOR, Dept. of EN



NOIDA INSTITUTE OF ENGINEERING & TECHNOLOGY, GREATER NOIDA
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Certificate

This is to certify that the Seminar report entitled **“WIRELESS ELECTRICITY TRANSMISSION (WITRICITY)** is a record of the bonafide work done by **PRASOON PURWAR, 0813321059** under our supervision and guidance.

This report is submitted to the Noida Institute of E ngineering & Technology as a part of syllabus prescribed by GAUTAM BUDHA TECHNICAL UNIVERSITY, LUCKNOW for the Degree of Bachelor of Technology (Electronics & communication Engineering)

During the academic year of 2010-11.

We wish best for his endeavor.

Mr. S VIKRAM SINGH

Asst. Professor

Electrical & Electronics. Engg.

Dr. S. Gairola

Head of the Department

Electrical & Electronics. Engg.

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April
Gr. Noida

PRASOON PURWAR

ABSTRACT

Wireless electricity is also known as Witricity. Transmission of electrical energy from one object to another without the use of wires is called as WiTricity. WiTricity will ensure that the cellphones, laptops, iPods and other power hungry devices get charged on their own, eliminating the need of plugging them in and with every family member owning their cellphones, the drawers are overflowing with all sorts of wires. How many times have you wished if there could be some way to do away with all the wiry clutter? When you are on the way to work and your cellphone beeps in hunger for a battery charge, haven't you wished for your cellphone battery to get 'self charged'. Even better, because of WiTricity some of the devices won't require batteries to operate.

The Brain behind WiTricity is of Prof. Marin Soljacic from Massachusetts Institute of Technology (MIT), is the one who has proved that magnetic coupled resonance can be utilized in order to transfer energy without wires. What's even more interesting is how he came about this idea. Soljacic, just like any of us was fed up of his 'low battery' beeping cellphone and wondered just like any of us if there was a way to get rid of this 'charging problem'

But this remarkable discovery of the "True Wireless" and the principles upon which transmission and reception, even in the present day systems, are based, Dr. Nikola Tesla shows us that he is indeed the "Father of the Wireless." The most well-known and famous Wardenclyffe Tower (Tesla Tower) was designed and constructed mainly for wireless transmission of electrical power, rather than telegraphy. The most popular concept known is Tesla Theory in which it was firmly believed that Wardenclyffe, would permit wireless transmission and reception across large distances with losses. In spite of this he had made numerous experiments of high quality to validate his claim of possibility of wireless transmission of electricity. But this was an unfortunate incidence that people of that century was not in a position to recognise his splendid work otherwise today we may transmit electricity wirelessly and will convert our mother earth a wonderful adobe full of electricity

WiTricity - Wireless Electricity, these words are simpler said than done. The concept behind this fascinating term is a little complex. However, if you want to understand it, try and picture what I state in the next few lines. Consider two self resonating copper coils of same resonating frequency with a diameter 20 inches each. One copper wire is connected to the power source (WiTricity transmitter), while the other copper wire is connected to the device (WiTricity Receiver).

The electric power from the source causes the copper coil connected to it to start oscillating at a particular (MHz) frequency. Subsequently, the space around the copper coil gets filled with non-magnetic radiations. This generated magnetic field further transfers the power to the other copper coil connected to the receiver. Since this coil is also of the same frequency, it starts oscillating at the same frequency as the first coil. This is known as 'coupled resonance' and is the principle behind WiTricity.

MIT's WiTricity is only 40 to 45% efficient and according to Soljacic, they have to be twice as efficient to compete with the traditional chemical batteries. The team's next aim is to get a robotic vacuum or a laptop working, charging devices placed anywhere in the room and even robots on factory floors. The researchers are also currently working on the health issues related to this concept and have said that in another three to five years time, they will come up with a WiTricity system for commercial use.

WiTricity, if successful will definitely change the way we live. Imagine cellphones, laptops, digital camera's getting self charged! Wow! Let's hope the researchers will be able to come up with the commercial system soon. Till then, we wait in anticipation!

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1. Introduction

In this era of modernization, electricity has become the cup of life. A moment without electricity makes your thinking go dry. The major source of conventional form of electricity is through wires. The continuous research and development has brought forward a major breakthrough, which provides electricity without the medium of wires. This wonder baby is called WiTricity.

There are certain small but very useful discoveries made in history, which changed the world forever, Newton's gravitational law, Watt's steam engine, Thomson's bulb and many more. But a renaissance occurred with the invention of Electromagnetic Waves by Maxwell. Sir Jagdish Chandra Bose successfully generated electromagnetic waves having wavelength in the range of 5mm to 25 mm. Thereafter an Italian scientist named Marconi succeeded in transmitting electromagnetic waves up to a distance of several miles.

And with this there started a new era called WIRELESS TECHNOLOGY. Today, as we can see the word 'wireless' is common in day – to – day life. Wireless communication has made the world smaller. Almost each and everything is wireless or cordless. Cordless mouse, cordless keyboard, satellite communication, mobiles, cordless microphones and headphones, wireless internet service i.e. WIFI, etc. And these have definitely increased the standard of living.

In fact it dates back to the 19th century, when Nikola Tesla used conduction based systems instead of resonance magnetic field to transfer wireless power. As it is in Radiative mode, most of the Power was wasted and has less efficiency. Further, in 2005, Dave Gerding coined the term 'Wireless Power' and it has become a hot topic for researchers today.



Moreover, we all are aware of the use of electromagnetic radiations (radiowaves) which is quite well known for wireless transfer of information. In addition, lasers have also been used to transmit energy without wires. However, radio waves are not feasible for power transmissions because the nature of the radiation is such that it spreads across the place, resulting into a large amount of radiations being wasted. And in the case of lasers, apart from requirement of uninterrupted line of sight (an obstacle hinders the transmission process). It is also very dangerous WiTricity is nothing but **wireless electricity**. Transmission of electrical energy from one object to another without the use of wires is called as WiTricity. WiTricity will ensure that the cellphones, laptops, iPods and other power hungry devices get charged on their own, eliminating the need of plugging them in. Even better, because of WiTricity some of the devices won't require batteries to operate.

2. Witricity technology: The Basic

Witricity technology is transferring electric energy or power over distance without wires. with the basics of electricity and magnetism, and work our way up to the *Witricity* technology.

Electricity: The flow of electrons (current) through a conductor (like a wire), or charges through the atmosphere (like lightning). A convenient way for energy to get from one place to another!

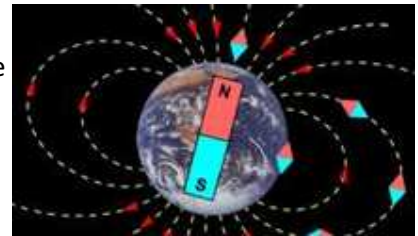
Magnetism: A fundamental force of nature, which causes certain types of materials to attract or repel each other. Permanent magnets, like the ones on your refrigerator and the earth's magnetic field, are examples of objects having *constant* magnetic fields.

Oscillating magnetic fields vary with time, and can be generated by alternating current (AC) flowing on a wire. The strength, direction, and extent of magnetic fields are often represented and visualized by drawings of the magnetic field lines.

Electromagnetism: A term for the interdependence of time-varying electric and magnetic fields. For example, it turns out that an oscillating magnetic field produces a magnetic an electric field *and* an oscillating electric field produces field.

Magnetic Induction: A loop or coil of conductive material like copper, carrying an alternating current (AC), is a very efficient structure for generating or capturing a magnetic field.

If a conductive loop is connected to an AC power source, it will generate an oscillating magnetic field in the vicinity of the loop. A second conducting loop, brought close enough to the first, may "capture" some portion of that oscillating magnetic field, which in turn, generates or induces an electric current in the second coil. The current generated in the second coil may be used to power devices. This type of electrical power transfer from one loop or coil to another is well known and referred to as magnetic induction. Some common examples of devices based on magnetic induction are electric transformers and electric generators.



An illustration representing the earth's magnetic field

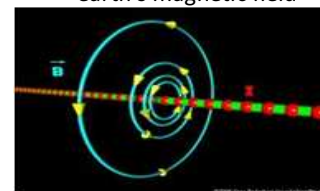


Figure 1

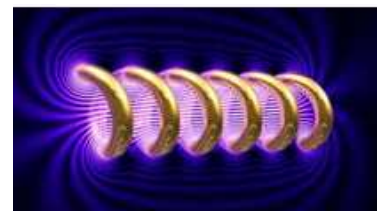
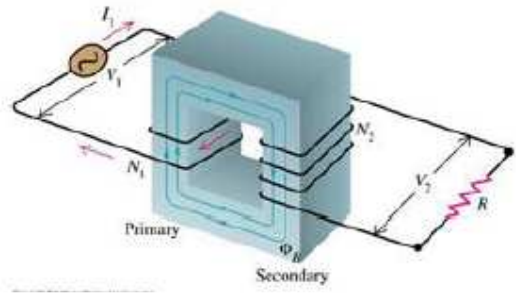


Figure 2

(figure 1)
As electric current, I flow in the circuit it give rise to a magnetic field, which wrap aroud wire and when current is reversed magnetic field also get reversed

(figure 2)
The blue lines represent the magnetic field when current flows through a coil and current is reversed , magnetic field also get reversed

Energy/Power Coupling: Energy 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 a 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.

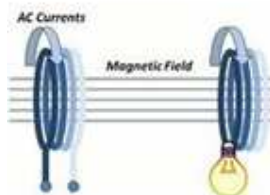


An electric transformer is a device that uses magnetic induction to transfer energy from its primary winding to its secondary winding, without the windings being connected to each other. It is used to "transform" AC current at one voltage to AC current at a different voltage.

Resonance: Resonance is a property that exists in many different physical systems. It can be thought of as the natural frequency at which energy can most efficiently be added to an oscillating system. A playground swing is an example of an oscillating system involving potential energy and kinetic energy. The child swings back and forth at a rate that is determined by the length of the swing. The child can make the swing go higher if she properly coordinates her arm and leg action with the motion of the swing. The swing is oscillating at its resonant frequency and the simple movements of the child efficiently transfer energy to the system. Another example of resonance is the way in which a singer can shatter a wine glass by singing a single loud, clear note.

In this example, the wine glass is the resonant oscillating system. Sound waves traveling through the air are captured by the glass, and the sound energy is converted to mechanical vibrations of the glass itself. When the singer hits the note that matches the resonant frequency of the glass, the glass absorbs energy, begins vibrating, and can eventually even shatter. The resonant frequency of the glass depends on the size, shape, thickness of the glass, and how much wine is in it.

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



Two idealized resonant magnetic coils, shown in yellow. The blue and red color bands illustrate their magnetic fields. The coupling of their respective magnetic fields is indicated by the connection of the color bands.

WiTricity Technology: *WiTricity* power sources and capture devices are specially designed magnetic resonators that efficiently transfer power over large distances via the magnetic near-field. These proprietary source and device designs and the electronic systems that control them support efficient energy transfer over distances that are many times the size of the sources/devices themselves.



The *WiTricity* power source, left, is connected to AC power. The blue lines represent the magnetic near field induced by the power source. The yellow lines represent the flow of energy from the source to the *WiTricity* capture coil, which is shown powering a light bulb. Note that this diagram also shows how the magnetic field (blue lines) can wrap around a conductive obstacle between the power source and the capture device.

3. The Invention of Witricity

Technology

Initiation

The story started late one night a few years ago, with MIT Professor Marin Soljačić standing in his pajamas, staring at his cell phone on the kitchen counter. It was probably the sixth time that month that he was awakened by his mobile phone beeping to let him know that he had forgotten to charge it. At that moment, it occurred to him: "There is electricity wired all through this house, all through my office—everywhere. This phone should take care of its own charging!" But to make this possible, one would have to find a way to transfer power from the existing wired infrastructure to the cell phone—without wires. Soljačić started thinking of physical phenomena that could make this dream a reality.

Coupled Resonators was fit for the situation

To achieve wireless power transfer in a way that is practical and safe, one needs to use a physical phenomenon that enables the power source and the device (in this case, the mobile phone) to exchange energy strongly, while interacting only weakly with living beings and other environmental objects, like furniture and walls. The phenomenon of *coupled resonators* precisely fits this description. Two resonant objects of the same resonant frequency tend to exchange energy efficiently, while interacting weakly with extraneous off-resonant objects.

A child on a swing is a good example of a resonant system. A swing exhibits a type of mechanical resonance, so only when the child pumps her legs at the natural frequency of the swing is she able to impart substantial energy into the motion of the swing. Another example involves acoustic resonances: imagine a room with 100 identical wine glasses, but each filled with wine up to a different level, so that each resonates at a different frequency (that is, they each emit a different tone or note when tapped, by a utensil, for example). If an opera singer enters that room and sings a very loud single note, the glass having the corresponding resonant frequency can accumulate enough energy to shatter, while the other glasses are unaffected.

Strong Coupling

Coupled resonators are said to operate in a *strongly coupled* regime if their energy transfer rate is substantially higher than the rate at which they lose energy due to factors such as material absorption and radiation. In the strongly coupled regime, energy transfer can be very efficient. These considerations are universal, applying to all kinds of resonances (e.g., acoustic, mechanical, electromagnetic, etc.). Soljačić and his colleagues at MIT (Karalis and Joannopoulos) set out to explore and develop the physical theory of how to enable strongly coupled magnetic resonators to transfer power over distances that would enable the kind of wireless device charging that Soljačić first imagined. Their theoretical results were published first in 2006, and again in 2008 in the *Annals of Physics*.

Once the physical theories were developed, Soljačić and his team (Kurs, Karalis, Moffatt, Joannopoulos, Fisher) set out to validate them experimentally. The theory was developed to cover a broad range of coupled resonator systems, but the experimental work focused on proving that magnetically coupled resonators could exchange energy in the manner predicted by the theory and required for the wireless charging of devices, such as cell phones. The team explored a system of two electro-magnetic resonators coupled through their magnetic fields. They were able to identify the strongly coupled regime in this system, and showed that strong coupling could be achieved over distances that greatly exceeded the size of the resonant objects themselves. The team had proven that in this strongly coupled regime, efficient wireless power transfer could be enabled. Their successful experiment was published in the journal, *Science* in 2007.

WiTricity Technology is Born

The experimental design consisted of two copper coils, each a self-resonant system. One of the coils, connected to an AC power supply, was the resonant *source*. The other coil, the resonant *capture device*, was connected to a 60 watt light bulb. The power source and capture device were suspended in mid-air with nylon thread, at distances that ranged from a few centimeters to over 2.5 meters (8.2 ft). Not only was the light bulb illuminated, but the theoretical predictions of high efficiency over distance were proven experimentally. By placing various objects between the source and capture device, the team demonstrated how the magnetic near field can transfer power through certain materials and around metallic obstacles.

Thus Prof. Soljačić's dream of finding a method to wirelessly connect mobile electric devices to the existing electric grid was realized. WiTricity Corp. was soon launched to carry this technology forward from the MIT laboratories to commercial production.

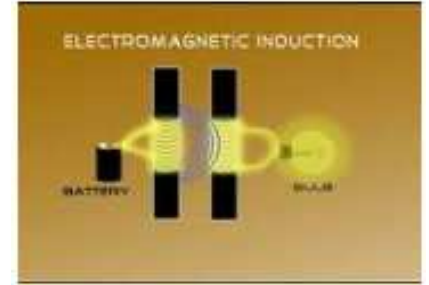
The inventors of Witricity are the researchers from the team from Massachusetts Institute of Technology. They are the people who had coined the phrase of Witricity and this invention can change the way electricity is used today This team from MIT belonged to the Department of Physics, Department of Electrical Engineering and Computer Science and the Institute for Soldier Nanotechnologies. The members of this team were Andre Kurs, Aristeidis Karalis, Prof. Peter Fisher, Robert Moffat and Prof. John Joannopoulos. The leader of this team of researchers was Prof, Marin soljadic.



4 . Wiricity Technology Is More Than.....

1. Traditional Magnetic Induction

At first glance, WiTricity technology for power transfer appears to be traditional magnetic induction, such as is used in power transformers, where conductive coils transmit power to each other wirelessly, over very short distances. **Inductive charging** uses the electromagnetic field to transfer energy between two objects. A charging station sends energy through inductive coupling to an electrical device, which stores the energy in the batteries. Because there is a small gap between the two coils, inductive charging is one kind of short-distance wireless energy transfer. The two coils must be very close together, and may even overlap, but the coils do not make direct electrical contact with each other. Induction chargers typically use an induction coil to create an alternating electromagnetic field from within a charging base station, and a second induction coil in the portable device takes power from the electromagnetic field and converts it back into electrical current to charge the battery. The two induction coils in proximity combine to form an electrical transformer. However, the efficiency of the power exchange in traditional magnetic induction systems drops by orders of magnitude when the distance between the coils becomes larger than their sizes. In addition to electric transformers, other devices based on traditional magnetic induction include rechargeable electric toothbrushes, and inductive "charging pads" which require that the object being charged be placed directly on top of, or very close to, the base or pad supplying the power.



Magnetic Induction transfer of Energy



Magnetic Induction charging of car

The power exchange efficiency of some induction systems is improved by utilizing resonant circuits. These so-called *resonantly enhanced induction* techniques are used in certain medical implants and high-frequency RFIDs for example. However, to the best of our knowledge, WiTricity founding technical team was the first to discover that by specially designing the magnetic resonators, one could achieve *strong coupling* and highly efficient energy exchange over distances much larger than the size of the resonator coils, distances very large compared to traditional schemes.

Inductive charging carries a far lower risk of electrical shock, when compared with conductive charging, because there are no exposed conductors. The ability to fully enclose the charging connection also makes the approach attractive where water impermeability is required; for instance, inductive charging is used for implanted medical devices that require periodic or even constant external power, and for electric hygiene devices, such as toothbrushes and shavers, that are frequently used near or even in water

2. Radiative Power Transfer

WiTricity technology for power transfer is non-radiative and relies on near-field magnetic coupling. Many other techniques for wireless power transfer rely on radiative techniques, either broadcasted or narrow beam (directed radiation) transmission of radio, or light waves. Broadcasted radiation of radio frequency energy is commonly used for wireless information transfer because information can be transmitted over a wide area to multiple users. The power received by each radio or wireless receiver is miniscule, and must be amplified in a receiving unit using an external power supply. Because the vast majority of radiated power is wasted into free space, radio transmission is considered to be an inefficient means of power transfer. Note that while more energy can be supplied to the receiver by "cranking up the power" of the transmitters in these systems, such high power levels may pose a safety hazard and may interfere with other radio frequency devices



In addition to radio waves, visible and invisible light waves can also be used to transfer energy. The sun is an excellent radiative source of light energy, and industry and academia are working hard to develop photovoltaic technologies to convert sunlight to electrical energy. A laser beam is a form of *directed* light radiation, in which visible or invisible light waves may be formed into a collimated beam, delivering energy in a targeted way. However, as in the case of directed radio waves, safe and efficient transmission of laser power requires a clear line of sight between the transmitter and receiver.

3. Magnetic Resonance Imaging(MRI)

MRI machines use "magnetic resonance imaging" to produce Diagnostic images of soft tissue. Many people assume that WiTricity "Resonant Magnetic Coupling" must be similar to magnetic resonance imaging (MRI) technology however; the technologies are similar in name only. MRI is, as its name suggests, a technology for using magnetism as a basis for diagnostic *imaging* of soft tissue in the human body. It utilizes a strong DC magnet to orient the magnetic fields of atoms within tissues, and radio frequency fields to manipulate those atoms in a selective way, so that tissues and structures can be imaged clearly. The "resonance" referred to in "MRI" refers to the resonance of Atomic structures. MRI is not considered to be a method for wireless power transfer.



4. Tesla's Vision of a Wireless World

In the late 1800's and early 1900's, at the dawn of the electrification of the modern world, some scientists and engineers believed that using wires to transfer electricity from every place it was generated to every place that it could be used would be too expensive to be practical. Nikola Tesla, one of the most well known of these scientists, Had a vision for a wireless world in which wireless electric power and communications would reach around the world, delivering information and power to ships at sea, factories, and every home on the planet. Tesla contributed significantly to our understanding of electricity and electrical systems and is credited with inventing three-phase AC power systems, induction motors, fluorescent lamps, radio transmission, and various modes of wireless electric power transfer. *WiTricity* technology for power transfer is different than the technologies proposed by Tesla, but his work is referenced and acknowledged in the scientific articles published by *WiTricity* founding technical team.



Nikola Tesla's Wardenclyffe tower built on Long Island, NY in 1904. This tower was intended to implement Tesla's vision of transmitting power and information around the world. The tower was destroyed in 1917.

5. Features and Benefits

1. Highly Resonant Strong Coupling Provides High Efficiency Over Distance

WiTricity mode of wireless power transfer is highly efficient over distances ranging from centimeters to several meters. Efficiency may be defined as the amount of usable electrical energy that is available to the device being powered, divided by the amount of energy that is drawn by the *WiTricity* source. In many applications, efficiency can exceed 90%. And *WiTricity* sources only transfer energy when it is needed. When a WiTricity powered device no longer needs to capture additional energy, the *WiTricity* power source will automatically reduce its power consumption to a power saving "idle" state.

2. Energy Transfer via Magnetic Near Field Can Penetrate and Wrap Around Obstacles

The magnetic near field has several properties that make it an excellent means of transferring energy in a typical consumer, commercial, or industrial environment. Most common building and furnishing materials, such as wood, gypsum wall board, plastics, textiles, glass, brick, and concrete are essentially "transparent" to magnetic fields—enabling *WiTricity* technology to efficiently transfer power through them. In addition, the magnetic near field has the ability to "wrap around" many metallic obstacles that might otherwise block the magnetic fields. WiTricity applications engineering team will work with you to address the materials and environmental factors that may influence wireless energy transfer in your application.

3. Non-Radiative Energy Transfer is Safe for People and Animals

WiTricity technology is a non-radioactive mode of energy transfer, relying instead on the magnetic near field. Magnetic fields interact very weakly with biological organisms—people and animals—and are scientifically regarded to be safe. Professor Sir John Pendry of Imperial College London, a world renowned physicist, explains: "The body really responds strongly to *electric* fields, which is why you can cook a chicken in a microwave. But it doesn't respond to *magnetic* fields. As far as we know the body has almost zero response to magnetic fields in terms of the amount of power it absorbs." Evidence of the safety of magnetic fields is illustrated by the widespread acceptance and safety of household magnetic induction cook tops.

Through proprietary design of the *WiTricity* source, electric fields are almost completely contained within the source. This design results in levels of electric and magnetic fields which fall well within regulatory guidelines. Thus *WiTricity* technology doesn't give rise to radio frequency emissions that interfere with other electronic devices, and is not a source of electric and magnetic field levels that pose a risk to people or animals.

Limits for human exposure to magnetic fields are set by regulatory bodies such as the FCC, ICNIRP, and are based on broad scientific and medical consensus. *WiTricity* technology is being developed to be fully compliant with applicable regulations regarding magnetic fields and electromagnetic radiation.

4. Scalable Design Enables Solutions from mill watts to Kilowatts

WiTricity systems can be designed to handle a broad range of power levels. The benefits of highly efficient energy transfer over distance can be achieved at power levels ranging from mill watts to several kilowatts. This enables *WiTricity* technology to be used in applications as diverse as powering a wireless mouse or keyboard (mill watts) to recharging an electric passenger vehicle (kilowatts). *WiTricity* technology operates in a "load following" mode, transferring only as much energy as the powered device requires.

5. Flexible Geometry Allows *WiTricity* Devices to be Embedded Into OEM Products

WiTricity technology is being designed so that it can be easily embedded into a wide variety of products and systems. The physics of resonant magnetic coupling enables *WiTricity* engineers to design power sources and devices of varying shapes and sizes, to match both the packaging requirements and the power transfer requirements in a given OEM application. *WiTricity* has designed power capture devices compact enough to fit into a cell phone



WiTricity Applications

WiTricity wireless power transfer technology can be applied in a wide variety of applications and environments. The ability of our technology to transfer power safely, efficiently, and over distance can improve products by making them more convenient, reliable, and environmentally friendly. *WiTricity* Technology can be used to provide:

Direct Wireless Power— when all the power a device needs is provided wirelessly and no batteries are required. This mode is for a device that is always used within range of its *WiTricity* power source.

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 both in and out of range of its *WiTricity* power source.

WiTricity technology is designed for Original Equipment Manufacturers (OEM's) to embed directly in their products and systems.

WiTricity technology will make your products:

More Convenient:

- No manual recharging or changing batteries.
- Eliminate unsightly, unwieldy and costly power cords.

More Reliable:

- Never run out of battery power.
- Reduce product failure rates by fixing the 'weakest link': flexing wiring and mechanical Interconnects.

More Environmentally Friendly:

- Reduce use of disposable batteries.
- Use efficient electric 'grid power' directly instead of inefficient battery charging.

Consumer Electronics

- Automatic wireless charging of mobile electronics (phones, laptops, game controllers, etc.) in home, car, office, Wi-Fi hotspots while devices are in use and mobile.
- Direct wireless powering of stationary devices (flat screen TV's, digital picture frames, home theater accessories, wireless loud speakers, etc. eliminating expensive custom wiring, unsightly cables and "wall-wart" power supplies.
- Direct wireless powering of desktop PC peripherals: wireless mouse, keyboard, printer, speakers, display, etc. eliminating disposable batteries and awkward cabling.



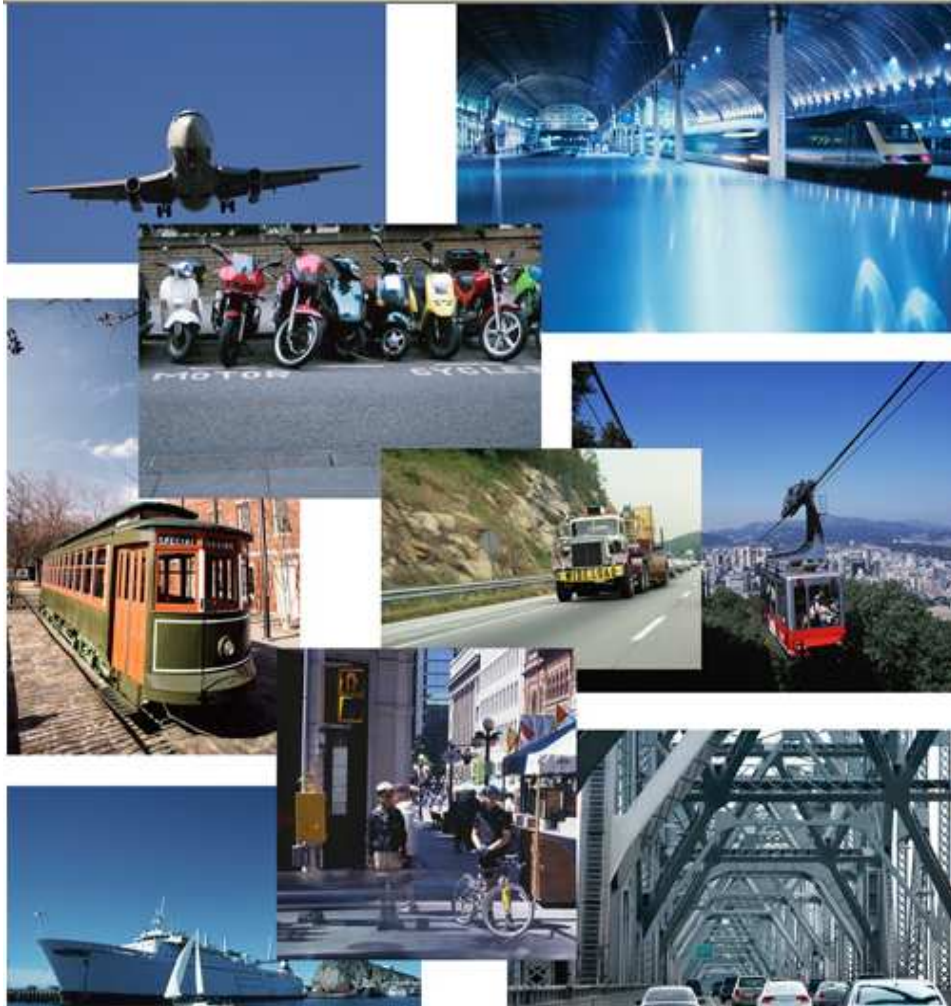
Industrial

- Direct wireless power and communication interconnections across rotating and moving "joints" (robots, packaging machinery, assembly machinery, machine tools) eliminating costly and failure-prone wiring.
- Direct wireless power and communication interconnections at points of use in harsh environments (drilling, mining, underwater, etc.) where it is impractical or impossible to run wires.
- Direct wireless power for wireless sensors and actuators, eliminating the need for expensive power wiring or battery replacement and disposal.



Transportation

- Automatic wireless charging for existing electric vehicle classes: golfcarts, industrial vehicles.
- Automatic wireless charging for future hybrid and all-electric passenger and commercial vehicles, at home, in parking garages, at fleet depots, and at remote kiosks.
- Direct wireless power interconnections to replace costly vehicle wiring harnesses and slip ring



Other Applications

- Direct wireless power interconnections and automatic wireless charging for implantable medical devices (ventricular assist devices, pacemaker, defibrillator, etc.).
- Automatic wireless charging and for high tech military systems (battery powered mobile devices, covert sensors, unmanned mobile robots and aircraft, etc.).
- Direct wireless powering and automatic wireless charging of smart cards.
- Direct wireless powering and automatic wireless charging of consumer appliances, mobile robots, etc.



7. QUESTIONNAIRE

The concept being so new and innovative brings in so many questions. Hereafter, some questions are being answered on the basis of study done on the topic and relevant topics.

Is WiTricity technology safe?

Human beings or other objects placed between the transmitter and receiver do not hinder the transmission of power. WiTricity technology is a non-radiative mode of energy transfer, relying instead on the magnetic near field. Magnetic fields interact very weakly with biological organisms—people and Animals—and are scientifically regarded to be safe. *WiTricity* products are being designed to comply with applicable safety standards and regulations.

How much power can be transferred?

Till now, Scientists has been able to transfer more than 60W power. The technology by itself is capable of scaling from applications requiring milliwatts to those requiring several kilowatts of power.

Over what distance can *WiTricity* technology transfer power?

WiTricity technology is designed for "mid-range" distances, which we consider to be anywhere from a centimeter to several meters. The actual operating range for a given application is determined by many factors, including power source and capture device sizes, desired efficiency, and the amount of power to be transferred.

How efficient is WiTricity technology?

The power transfer efficiency of a *WiTricity* solution depends on the relative sizes of the power source and capture devices, and on the distance between the devices. Maximum efficiency is achieved when the devices are relatively close to one another, and can exceed 95%.

What's the Future of WiTricity?

MIT's WiTricity is only 40 to 45% efficient and according to Soljacic, they have to be twice as efficient to compete with the traditional chemical batteries. The team's next aim is to get a robotic vacuum or a laptop working, charging devices placed anywhere in the room and even robots on factory floors. The researchers are also currently working on the health issues related to this concept and have said that in another three to five years time, they will come up with a WiTricity system for commercial use.

8. 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. Dr.N.Tesla is the pioneer of this invention. 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. It has a tremendous economic impact to human society.



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