

WITRICITY~ a Theft Free Solution To E-Waste Burden

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ABSTRACT

Can we imagine the life without electrical wires? From now onwards 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. When two magnetically Resonating objects at “Strongly coupled” regime tend to exchange energy efficiently by the 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. Now a days there is a Rapid development of autonomous electronics like Laptops, Cell-phones, Household 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 as they need midrange energy.[7]

I. INTRODUCTION

Now day’s electricity has become a cup of life. A moment without electricity makes your thinking go dry. 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 cell phone beeps in hunger for a battery charge, haven't you wished for your cell phone battery to get 'self charged'. The major source of conventional form of electricity is through wires. Most of the energy loss is during transmission, On an average energy loss is more than 30% and in India it exceeds by 40%. It is estimated that 40 million batteries per year add to the e-waste burden, which is of course not a good sign. 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 for ever, 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 fields to transfer wireless power shown in Fig 1. As it is in Radioactive mode, most of the Power was wasted and has less efficiency. Further, in 2005, Dave Gerding coined the term Witricity which is being used by the MIT researchers and today’s world[8].

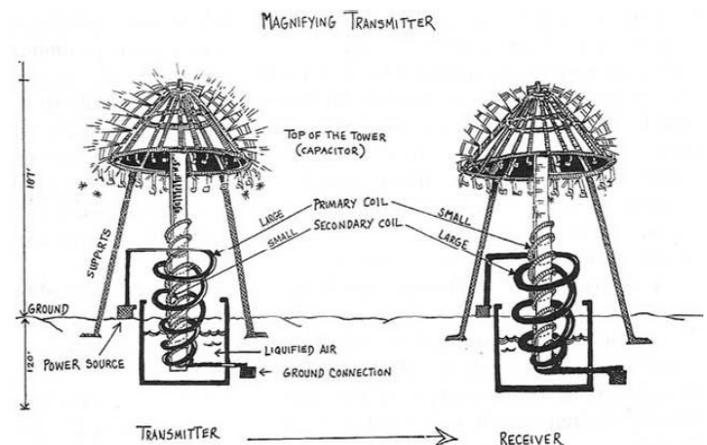


Fig 1. Nikola Tesla's WardenClyffe Tower built on long Island, NY in 1904.

II. PROPOSED SYSTEM

The major problem which is faced worldwide, (whether be in wired or wireless power supply) is Power Theft. In the US, the consensus seems to be that theft costs between 0.5% and 3.5% of annual gross revenues. This seems like a small amount until you consider that US electricity revenues were in \$280 billion range in 1998. Therefore between \$1 and \$10 billion worth of electricity was stolen. The same can be in case with Witricity. Due to Wi-Fi, anyone can access it, and there is no security. If we think for security issues, as some password, then it may be true in case of Mobiles, Laptops, Tabs, but what about the other devices such as Tube lights, fans, or Mixer Grinder, we don't have input system for such devices.

A better solution to the ever rising Power theft in case of Witricity is we can use remotes. To implement Wireless Electricity we require a source, a remote, and there can be 'n' number no destination in the given room. This concept that can be applied for the future use is that we will give a unique ID to each and every source, and for each source there would be respective remotes with the same ID. If a device (destination) is in the range of Witricity, then it can access Electricity only if it gets activation from the remote of the same source in its range. If an unknown user comes in the range, he cannot have access to electricity as he doesn't have the remote, nor he could use his own remote as the ID are different. So in simple language, the source in range and the remote ID should be same to get the access. Also we will require sensors in the destination device to identify all the sources in its range. If the source ID and the remote ID is same then the circuit gets completed and the device gets access to the electricity.

This Benefits in one more case i.e. suppose there are 5 fans in the Laboratory and you alone are sitting for doing some Practical's. Through Witricity all the fans in that range will start, which is not a good option as there is just wastage of electricity. But through our concept we can avoid the above circumstance and can control the working of devices through remotes.

The way of looking towards the topic was just in a closed area point or view, i.e. in your homes, offices, you can avoid the wire cluttering but when we think at broad level, i.e. transferring of electricity through the power generator house to your place, the wires still exist. Billions of dollars

are invested in the wiring for connection. The biggest challenge in Witricity is How to Transfer Wireless Electricity through long distance with all safety measures? An alternative can be the use of already existing renewable source of electricity i.e. solar energy. The Solar Panels at your Terrace can convert the solar energy into electricity and then the whole house can be Wi-Fi, without any wires.

III. WITRICITY

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 cell phones, laptops, iPods and other power hungry devices get charged on their own, eliminating the need of plugging them in. 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. Even better, because of Witricity some of the devices won't enquire batteries to operate. Moreover, we all are aware of the use of electromagnetic radiation (radio waves) 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 (obstacles hinders the transmission process), it is also very dangerous(Ref. Fig 2). [8]

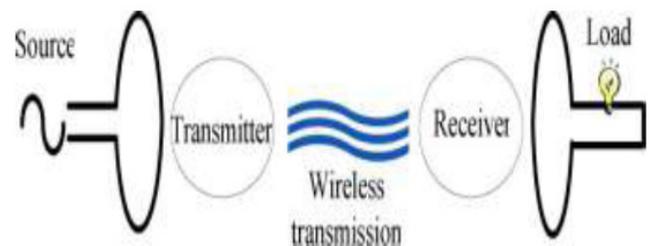


Fig 2. Basic Component of the Witricity System.

IV. NEED OF WITRICITY

Now a days there is a Rapid development of autonomous electronics like Laptops, Cell-phones, Household robots and all those 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.[7]

waves	ng			photocells, lenses, telescopes	aircraft, powering space elevator climbers.
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V. POWER TECHNOLOGY

These are the different wireless power technologies shown in following Table 1:

Table 1. Wireless Power Technology.

Technology	Range	Directivity	Frequency	Antenna devices	Current and or possible future applications
Inductive coupling	Short	Low	Hz - MHz	Wire coils	Electric tooth brush and razor battery charging, induction stovetops and industrial heaters.
Resonant inductive coupling	Mid-	Low	MHz - GHz	Tuned wire coils, lumped elements	Charging portable devices (Qi, WiTricity), biomedical implants, electric vehicles, powering busses, trains, MAGLEV, RFID, smartcards.
Capacitive coupling	Short	Low	kHz - MHz	Electrodes	Charging portable devices, power routing in large scale integrated circuits, Smartcards.
Magnetodynamic ^[13]	Short	N.A.	Hz	Rotating magnets	Charging electric vehicles.
Microwaves	Long	High	GHz	Parabolic dishes, phased arrays, rectennas	Solar power satellite, powering drone aircraft.
Light	Lo	High	≥THz	Lasers,	Powering drone

1) Inductive Coupling

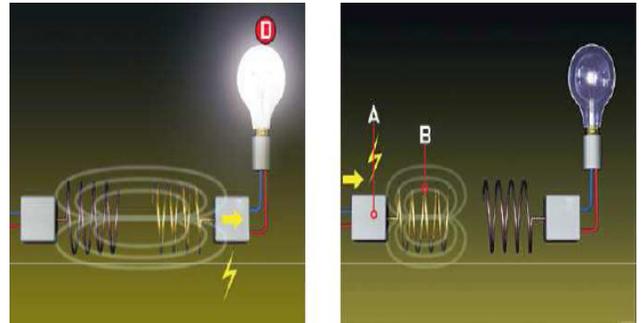


Fig 3. Inductive Coupling.

The electro-dynamic induction wireless transmission technique relies on the use of a magnetic field generated by an electric current to induce a current in a second conductor. This effect occurs in the electromagnetic near field, with the secondary in close proximity to the primary. As the distance from the primary is increased, more and more of the primary's magnetic field misses the secondary. Even over a relatively short range the inductive coupling is grossly inefficient, wasting much of the transmitted energy(Ref. Fig.3).

This action of an electrical transformer is the simplest form of wireless power transmission. The primary coil and secondary coil of a transformer are not directly connected; each coil is part of a separate circuit. Energy transfer takes place through a process known as mutual induction. Principal functions are stepping the primary voltage either up or down and electrical isolation. Mobile phone and electric toothbrush battery chargers, are examples of how this principle is used. Induction cookers use this method. The main drawback to this basic form of wireless transmission is short range. The receiver must be directly adjacent to the transmitter or induction unit in order to efficiently couple with it.

Common uses of resonance-enhanced electro dynamic induction are charging the batteries of portable devices such as laptop computers and cell phones, medical implants and electric vehicles. A localized charging technique selects the appropriate transmitting coil in a multilayer winding array structure. Resonance is used in both the wireless charging pad (the transmitter circuit) and the receiver module (embedded in the load) to maximize energy transfer

efficiency. Battery-powered devices fitted with a special receiver module can then be charged simply by placing them on a wireless charging pad. It has been adopted as part of the Qi wireless charging standard.

This technology is also used for powering devices with very low energy requirements, such as RFID patches and contactless smartcards. Instead of relying on each of the many thousands or millions of RFID patches or smartcards to contain a working battery, electro dynamic induction can provide power only when the devices are needed.[6]

2) Resonant Inductive Coupling

In 2006 MIT researchers discovered an efficient method to transfer power between coils separated by few meters. They extend the distance between coils in inductive coupling system by adding resonant coils shown in Fig 4. They demonstrated by sending electromagnetic waves around in a highly angular waveguide, evanescent waves are produced, which carry no energy. An evanescent wave is a near field standing wave exhibiting exponential decay with distance.

In resonant induction method induction can take place a little differently if the electromagnetic fields around the coils resonate at the same frequency. In this a curved coils of wire uses as an inductor. A capacitance plate which can hold a charge attaches to each end of the coil.

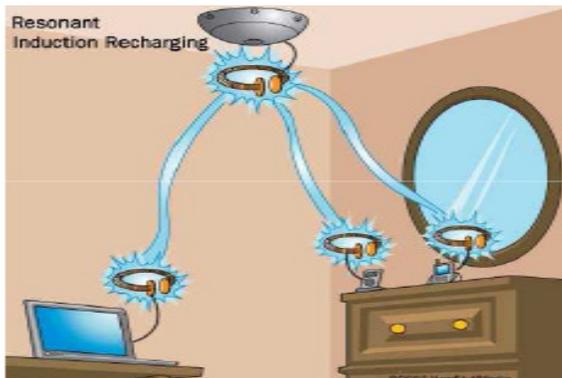


Fig 4. Inductive Coupling System with Resonant Coil.

As electricity travels through this coil the coil begins to resonate. Its resonant frequency is a product of the inductance of the coil and the capacitance of the plate. Unlike multiple layer secondary of nonresonant transformer single layer solenoids with closely spaced capacitor plates on each end as shown in figure 1 is used as transmitter and receiver.

Power is transmitted when the coils have same resonant frequency. By using resonant induction one coil can send electricity to several receiving coils as long as they all resonate at same frequency. The MIT team's preliminary work suggests that kind of setup could power or recharge all

the devices in one room. Some modifications would be necessary to send power over long distances, like the length of a building or a city. [6]

Other techniques like Capacitive Coupling, Magneto-dynamic, Microwaves and Light Waves are also shown in Table 1.

VI. EFFICIENCY OF WITRICITY

It is observed that efficiency decreases with increase in distance between source coil and load coil shown in Fig 5. [10]

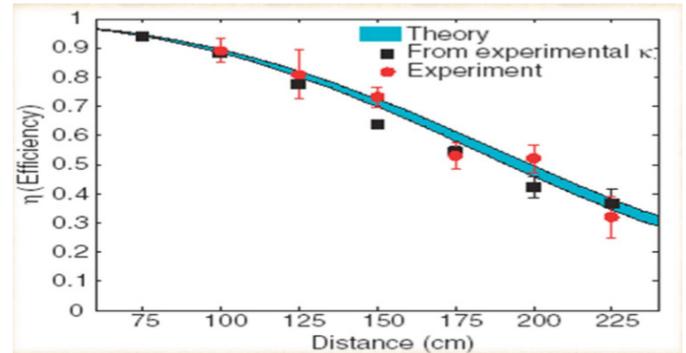


Fig 5. Efficiency Chart of WiTricity.

VII. FEATURES OF WITRICITY:

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. [7]

2) Energy Transfer via Magnetic Near Field Can Penetrate and Wrap Around Obstacle:

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. [7]

Benefits of WiTricity:

It will make 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. [9]

Advantages:

- Safe, fairly efficient, good range
- Boon for the devices which uses midrange power
- No need of line of sight.
- No need of power cables and batteries.
- Magnetic fields interact weakly with biological masses (humans), and energy is only transmitted between resonating objects. [10]

Limitations:

- Transmissions possible only in few meters.
- Possibility of "energy theft".
- Efficiency decreases with distance.
- The resonance condition should be satisfied and if any error exists, there is no possibility of power transfer. [10]

VIII. APPLICATIONS OF WITRICITY

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:

1) Automatic Wireless Power Charging: 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. 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.[9]



Fig 6. Automatic Wireless Charging of Mobile Electronics

2) Consumer Electronics: a) 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.

b) Direct wireless powering of stationary devices (flat screen TV's, digital picture frames, home theatre accessories, wireless loud speakers, etc.) eliminating expensive custom wiring, unsightly cables and wall-wart power supplies.

c) Direct wireless powering of desktop PC peripherals: wireless mouse, keyboard, printer, speakers, display, etc. eliminating disposable batteries and awkward cabling.[9]

3) Industrial: a) Direct wireless power and communication interconnections across rotating and moving joints (robots, packaging machinery, assembly machinery, machine tools) eliminating costly and failure-prone wiring.

b) Direct wireless power for wireless sensors and actuators, eliminating the need for expensive power wiring or battery replacement and disposal.[9]

4) Transportation: a) Automatic wireless charging for existing electric vehicle classes: golf carts, industrial vehicles.

b) 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.

c) Direct wireless power interconnections to replace costly vehicle wiring harnesses and slip rings.[9]

5) Medical Application: Wireless charging systems are being developed for implanted medical devices including Left ventricular assist device (LVAD) heart assist pumps, pacemakers, and infusion pumps. Using highly resonant wireless power transfer, such devices can be efficiently powered through the skin and over distances much greater than the thickness of the skin, so that power can be supplied to devices deeply implanted within the human body

6) Military Application: Designers of defence systems are able to utilize wireless charging to improve the reliability,

ergonomics, and safety of electronic devices. The Talon Teleoperated robot shown in Figure 9 is being equipped with wireless charging so that it can be recharged while it is being transported by truck from site to site. Helmet mounted electronics, including night vision and radio devices can be powered wirelessly from a battery pack carried in the soldier's vest, eliminating the need for disposable batteries or a power cord connecting the helmet to the vest mounted battery pack. [9]

Is WiTricity Technology Safe?

Non-Radiative Energy Transfer is Safe for People and Animals: - 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. 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. [7]

IX. CONCLUSION

This provides mid-range **non-radiative** energy transfer scheme based on **strongly-coupled** resonances. Even very simple design has promising performance and provides better efficiency with respect to distance. As a powerful concept, it could enable a wide range of applications. We can call WiTricity as future technology of Electricity transmission for power consumer. [7]

Future Scope:

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 cell phones, 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! Human beings or other objects placed between the transmitter and receiver do not hinder the transmission of power. However, does magnetic coupling or resonance coupling have any harmful effects on humans? MIT's researchers are quite confident that WiTricity's 'coupling resonance' is safe for humans. They say that the magnetic fields tend to interact very weakly with the biological tissues of the body, and so are not prone to cause any damage to any living beings. [7]

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