



**A TECHNICAL REPORT  
ON**

**WITRICITY**

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## **ABSTRACT**

The objective of this technical report is to provide [electrical energy](#) to remote objects without wires. Wireless energy transfer also known as wireless energy transmission is the process that takes place in any system where [electromagnetic](#) energy is transmitted from a power source to an electrical load, without interconnecting wires. Wireless transmission is employed in cases where interconnecting wires are inconvenient, hazardous, or impossible.

The principle of wireless electricity works on the principle of using coupled resonant objects for the transfer of electricity to objects without the use of any wires. A witricity system consists of a witricity transmitter and another device called the receiver.

The receiver works on the same principle as radio receivers where the device has to be in the range of the transmitter. It is with the help of resonant magnetic fields that witricity produces electricity, while reducing the wastage of power. The present report on witricity aims at power transmissions in the range of 100 watts. May be the products using WiTricity in future might be called Witric or Witric's.



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## **CHAPTER 1**

### **1.1 INTRODUCTION TO WITRICITY:**



## *Witricity*

**WITRICITY** is a term which describes wireless energy transfer, the ability to provide electrical energy to remote objects without wires. Wireless energy transfer also known as wireless energy transmission is the process that takes place in any system where electromagnetic energy is transmitted from a power source (such as a Tesla coil) to an electrical load, without interconnecting wires. Wireless transmission is employed in cases where interconnecting wires are inconvenient, hazardous, or impossible. Though the physics can be similar (pending on the type of wave used), there is a distinction from electromagnetic transmission for the purpose of transferring information (radio), where the amount of power transmitted is only important when it affects the integrity of the signal.

Electricity is today a necessity of modern life. It is difficult to imagine passing a day without electricity. The conventional use of electricity is made possible through the use of wires.

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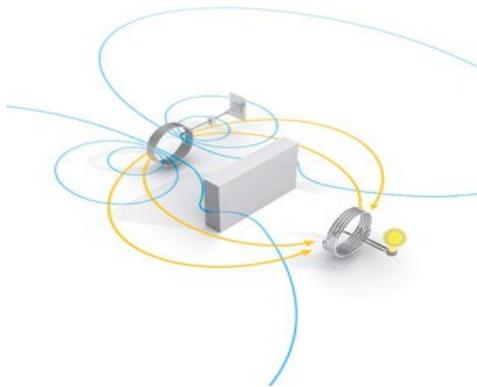
## CHAPTER 2

### 2.1 WITRICITY TECHNOLOGY:



## *Witricity*

*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.

## **2.2 COUPLED RESONATORS:**

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



*Witricity*

her leg at the natural frequency of the swing is she able to impart substantial energy into the motion of the swing.

### CHAPTER 3



### 3.1 NON-RADIATIVE POWER TRANSFER:

WiTricity's technology for power transfer is non-radiative and relies on near-field magnetic coupling and is different from radiative power transfer. 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.

"Directed radiation", using highly directional antennas, is another means of using radio transmission to beam energy from a source to a receiver. However, directed radiation—in particular microwave radiation—may interact strongly with living organisms and certain metallic objects. Such energy transfer methods may pose safety hazards to people or objects that obstruct the line-of-sight between the transmitter and receiver. These limitations make directed radio transmission impractical for delivering substantial levels of wireless power in a typical consumer, commercial, or industrial application. In fact, defense researchers are exploring the use of directed energy systems to deliver lethal doses of power to targets in space and on the battlefield.

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



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transmission of laser power requires a clear line of sight between the transmitter and receiver.

As mentioned at the beginning of this section, *Witricity*'s technology is based on non-radiative energy transfer. It does not require a clear line of sight between the power sources and capture devices and it is safe for use in typical home, hospital, office, or industrial environments.

### **3.2 FEATURES AND BENEFITS:**

#### **Highly Resonant Strong Coupling Provides High Efficiency Over Distance**

*Witricity*'s mode of wireless power transfer is highly efficient over distances ranging from centimeters to several meters. We define efficiency 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. Contact *Witricity* to learn the efficiency and distance ranges that can be achieved in your applications.

#### **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*'s applications engineering team will work with you to



*WiTricity*

address the materials and environmental factors that may influence wireless energy transfer in your application.

### **Non-Radiative Energy Transfer is Safe for People and Animals**

WiTricity's 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 cooktops.

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.

### **Scalable Design Enables Solutions from milliwatts 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 milliwatts to several kilowatts. This enables *WiTricity* technology to be used in applications as diverse as powering a wireless mouse or keyboard



*Witricity*

(milliwatts) 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.

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

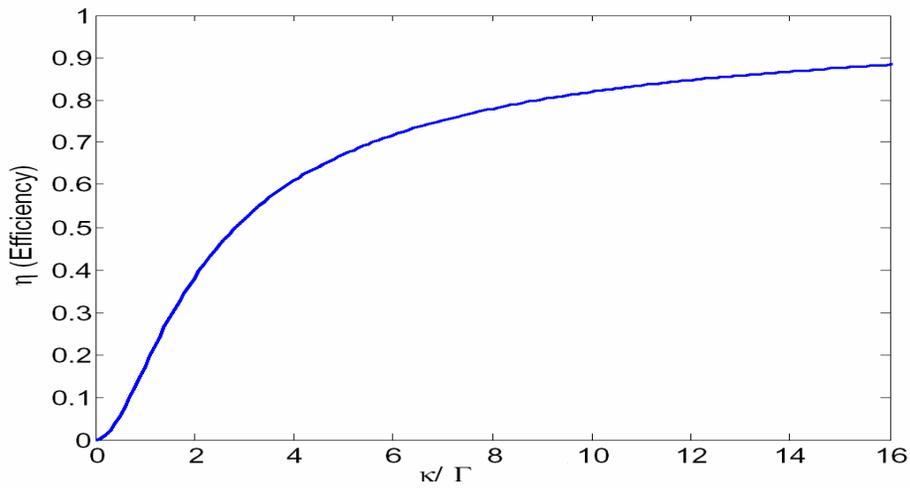
*WiTricity* technology is being designed so that it can be easily embedded into a wide variety of products and systems. The physics of resonant magnetic coupling enables *WiTricity* engineers to design power sources and devices of varying shapes and sizes, to match both the packaging requirements and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



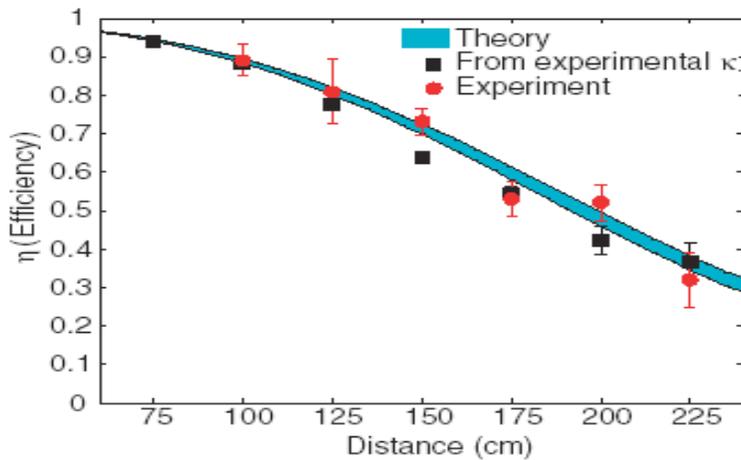
### 4.1 EFFICIENCY:

- In order for the power transfer to be efficient, we design the system such that the rate of energy transfer between the emitter and the receiver is greater than the rate of energy dissipation.
- This way the device can capture the energy and use it for useful work before too much of it get wasted away.
- Greater is the coupling factor( $k/T$ ) greater is the efficiency

**“Strong Coupling” ⇒ efficient transfer**



- Then the efficiency can also be calculated



**Is it practical and is it safe?**



- Witricity demonstration is still too recent, and too focused, to produce any definite conclusions.
- With the witricity method ,they anticipate transmitting power over distances about a meter, which is much less than ideal but still very impressive.
- If the technology is improved and honed to a point where it can be “productized” , it stands to turn any number of industries on their respective ears.
- The MIT team said its discovery is different from all previous effort because it uses “magnetically coupled resonance”, which means it will not only be safe but it will be fairly efficient.

## **CHAPTER 5**



*Witricity*

## **5.1 APPLICATIONS:**

WiTricity's 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.



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### **More Environmentally Friendly:**

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

Applications in various fields are

### **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.
- Automatic wireless charging for mobile robots, automatic guided vehicles, cordless tools and instruments...eliminating complex docking mechanisms, and labor intensive manual recharging and battery replacement.



## **Transportation**

- Automatic wireless charging for existing electric vehicle classes: golf carts, 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 rings.

## **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.

## **5.2 ADVANTAGES:-**

- The main advantages of this system is that we can get electricity anywhere without wires.
- The nature of power delivery is omni directional i.e. in every direction.
- Magnetic resonances are particularly suitable for everyday application because most of the common materials do not interact with magnetic fields, so interactions with environmental objects are suppressed even further.



## **CONCLUSION:**

This provides mid-range **non-radiative** energy transfer scheme based on **strongly-coupled** resonances. Even very simple designs have promising performance and provides better efficiency with respect to distance. As a powerful concept, it could enable a wide range of applications.