ABSTRACT

WITRICITY

The conventional use of electricity is made possible through the use of wires. However, wireless power transmission may allow other electronic devices to be completely free of the need to plug into a wall socket. Researchers in MIT have devised a means of providing electricity without any wires which is termed WITRICITY. Witricty works on the principle of using coupled resonant objects for the transference of electricity to objects without the use of any wires.

A witricty system consists of a witricty transmitter and the receiver which works on the 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 witricty produces electricity, while reducing the wastage of power. Witricty has many potential applications which include the powering of cell phones, house hold robots, laptops and other devices that normally run with the help of batteries or with plugging in of wires.
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Reference
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 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. WI-FI, 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. As it is in Radiative 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 today.

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 hinder 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 cell phones, 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.
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.

As electric current, I, flows in a wire, it gives rise to a magnetic field, B, which wraps around the wire. When the current reverses direction, the magnetic field also reverses its direction.

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 an electric field and an oscillating electric field produces a magnetic 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

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The blue lines represent the magnetic field that is created when current flows through a coil. When the current reverses direction, the magnetic field also
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 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.

**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.
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 or 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.

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.

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.
**PRINCIPLE:**

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), whereas the other copper wire is connected to the device (WiTricity receiver).

The electric power from the power source causes the copper coil connected to it to start oscillating at a particular frequency. Subsequently, the space around the copper coils 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 as the first coil, this is known as ‘COUPLED RESONANCE’ and is the principle behind WiTricity.
METHODS USED FOR WIRELESS POWER TRANSMISSION
INDUCTION (INDUCTIVE COUPLING)

This is the first method used for wireless power transfer. The simplest example for wireless energy transfer using this method is the electrical transformer. In this the primary and secondary circuits are electrically isolated from each other. The transfer of energy takes place by electromagnetic coupling through mutual induction. The main drawback of this method is the short range. For efficient working of a system which uses this method, the receiver must be in very close proximity to the transmitter. A larger, stronger field can be used for energy transfer over long distance, but this process is extremely inefficient. Since magnetic field spreads in all direction, making a large wastage of energy. 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. 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. These waves are always associated with
matter, and are most intense within one-third wavelength from any radio antenna. Evanescent means “tend to vanish”, the intensity of evanescent waves decays exponentially with the distance from the interface at which they are formed. If a proper resonant waveguide is brought near the transmitter, the evanescent waves can allow the energy to tunnel to the power drawing wave guide. Since the electromagnetic waves would tunnel, they would not propagate through the air and would not disrupt electronic devices or cause physical injury like microwave or radio waves do.

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. 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 non-resonant transformer single layer solenoids with closely spaced capacitor plates on each end as shown in figure1is used as transmitter and receiver.

![Inductor Coil and Capacitance Plate](image-url)
The MIT wireless power project uses a curved coil and capacitive plates.

Electricity traveling along an electromagnetic wave can tunnel from one coil to the other as long as they both have the same resonant frequency. As long as both the coils are out of range of one another nothing will happen, since the field around the coil are not strong enough to affect much around them. Similarly if two coils resonate at different frequencies nothing will happen. Figure 2 shows the working of wireless power transmission.

*1) Power from mains to antenna, which is made of copper
* 2) Antenna resonates at a frequency of about 1GHz, producing electromagnetic waves

* 3) 'Tails' of energy from antenna 'tunnel' up to 2m (6.5ft)

* 4) Electricity picked up by laptop's antenna, which must also be resonating at 1GHz. Energy used to recharge device

* 5) Energy not transferred to laptop re-absorbed by source antenna. People/other objects not affected as not resonating at 10MHz.

Fig. 3

By using resonant induction one coil can send electricity to several receiving coils as long as they all resonate at the 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. The figure 3 shows that a single transmitter can be used to charge several devices in a room.
The concept of WiTricity was made possible using resonance, where an object vibrates with the application of a certain frequency of energy. So two objects having similar resonance tend to exchange energy without causing any effect on the surrounding objects. To understand the energy transfer using resonant method considers an example involves acoustic resonances. Imagine a room with 100 identical wine glasses, each filled with wine up to a different level, so they all have different resonant frequencies. This is because objects physical structure determines the resonant frequency.

The frequency at which an object naturally vibrates is called resonant frequency. If a singer sings loudly inside the room, a glass of corresponding frequency might accumulate sufficient energy to even explode, while not influencing the other. In all the system of coupled resonators there exists a strongly coupled regime of operation. These considerations are universal, applying to all kinds of resonances. MIT researchers focused on magnetically coupled resonators and thus wireless power transmission over few meters are possible. This method is one million times as efficient as electromagnetic induction.
systems. This method is also called non-Radiative energy transfer, since it involves stationary fields around the coils rather than fields that spread in all direction.
The Invention of WiTricity Technology

How it started

The story started late one night a few years ago, with MIT Professor Marin Soljacic 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. Soljacic 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.).
Soljacic 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 Soljacic 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, Soljacic and his team (Kurs, Karalis, Moffatt, Joannopoulos, and 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 or 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 midair 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. Soljacic 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.

WITRICITY IN HISTORY

Wireless power transmission is not a new idea. Nickola 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
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 techniques for moving electricity over long distances without wires. Some exist only as theories or prototypes, but others are already in use. Consider an example, in this electric devices recharging without any plug-in. The device which can be recharged is placed on a charger. Supply is given to the charger and there is no electrical contact between charger and device. The recharging takes place in following steps.

1. Current from the wall outlet flows through a coil inside the charger, creating a magnetic field. In a transformer, this coil is called the primary winding.
2. When the device placed on the charger, the magnetic field induces a current in another coil, or secondary winding, which connects to the battery.
3. This current recharges the battery.
Figure 4 shows an electric toothbrushes cut section. It consists of two windings: primary and secondary. The primary winding is in the charger and the secondary winding is in the toothbrush. Figure 5 shows a camera and mobile placed on a charger for charging. By the use of this one or more devices can be charged at the same time.

Fig. 4: An electric toothbrush's base and handle contain coils that allow the battery to recharge.

Fig. 5: A Splash power mat uses induction to recharge multiple devices simultaneously.
WITRICITY AT PRESENT

In 2006 MIT researchers discovered a new method to provide electricity to remote objects without wires. Wiricity is based on coupled resonant objects. In 2007 researchers implemented a prototype using self resonant coils. In this first experiment they demonstrated efficient non-radiative power transfer over distance up to eight times the radius of the coils. This experiment was done using two copper coils. Each coil act as self resonant system. One of the coils is attached to the electricity source. Instead of irradiating the environment with electromagnetic waves, it fills the space with a non-radiative magnetic field oscillating at MHz frequencies. The non-radiative field mediates the power exchange with the other coil, which is specially designed to resonate with the field. The resonant nature ensures strong interaction between sending unit and receiving unit.

In the first experiment they successfully demonstrated the ability to power a 60W light bulb from
a power source that was 2 meters away with 40% efficiency approximately. They used two capacitively loaded copper coils of 51 cm in diameter designed to resonate in the MHz range. One coil was connected to a power source, the other to a bulb. In this experiment the coils were designed to resonate at 10MHz. The setup powered the bulb oh even when the coils were not in line of sight. The bulb glowed even when wood, metal, and other devices were placed in between the coils.

The figure given below shows the experimental setup. In which the transmitter and receiver coils are separated at a distance of 2m. The bulb connected to receiver coils is glowed when supply is given to transmitter coil as shown in figure. In the first figure transmitter and receiver coils are in direct line of sight. If a wooden piece is placed in between transmitter and receiver coils then also power transmission is possible.
Outcome
Transference of 40% of electricity occurs even through wood, metal and other devices when placed in between two coils.

RANGE AND RATE OF COUPLING

Using Coupled Mode Theory (CMT), we can give some framework to the system. The field system of the two resonant objects 1,2 is

\[ F(r,t) = a_1(t)F_1(r) + a_2(t)F_2(r) \]

Where \( F_1,2(r) \) are the resonating modes of 1 and 2 alone, and then the field amplitudes of \( a_1(t) \) and \( a_2(t) \). The lower order representation of the system is given by:
Where \( \omega_1, \omega_2 \) are the individual frequencies. \( \Gamma_1, \Gamma_2 \) are the resonance widths (decay rates) due to the object’s intrinsic (absorption, radiation, etc) losses and ‘\( \kappa \)’ is the coupling coefficient.

The solution of the equation show that at exact resonance at

\[
\omega_1 = \omega_2 \quad \text{and} \quad \Gamma_1 = \Gamma_2
\]

the normal modes of the combined system are split by \( 2\kappa \)

Ratio \( \frac{\kappa}{\sqrt{\Gamma_1, \Gamma_2}} \) shows that, it will set as figure-of-merit for any system under consideration for wireless energy transfer, along with the distance over which this ratio can be achieved.

The desired regime \( \frac{\kappa}{\sqrt{\Gamma_1, \Gamma_2}} >> 1 \) is called “strong coupling” regime. There is no change in energy, unless \( \kappa/\Gamma >> 1 \) is true.
Simulation model
Using COMSOL:

Simulation Performance:

By the basic parameters, calculated results and performance given with and with out the external object in between the coils.
## Comparison of Results:

### Results without Extraneous objects:

<table>
<thead>
<tr>
<th>Two loops</th>
<th>$D/r$</th>
<th>$Q_{\text{rad}}$</th>
<th>$Q = \omega/2\Gamma$</th>
<th>$\omega/2\kappa$</th>
<th>$\kappa/\Gamma$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$R=30\text{cm}, a=2\text{mm}, E=10, D=4\text{mm}, Q_{\text{abs}}=4886$</td>
<td>3</td>
<td>30729</td>
<td>4216</td>
<td>63.7</td>
<td>68.7</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>29577</td>
<td>4194</td>
<td>248</td>
<td>17.8</td>
</tr>
</tbody>
</table>

### Results with Extraneous objects:

<table>
<thead>
<tr>
<th>Two loops</th>
<th>$D/r$</th>
<th>$Q_{\text{rad}}$</th>
<th>$Q = \omega/2\Gamma$</th>
<th>$\omega/2\kappa$</th>
<th>$\kappa/\Gamma$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$R=30\text{cm}, a=2\text{mm}, E=10, D=4\text{mm}, Q_{\text{abs}}=4886$</td>
<td>3</td>
<td>30729</td>
<td>4136</td>
<td>62.6</td>
<td>67.4</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>29577</td>
<td>4106</td>
<td>235</td>
<td>17.6</td>
</tr>
</tbody>
</table>
The image above shows how coils connected to a power source and to devices facilitate the transfer of electromagnetic waves that are then used to power the device. The technology is based on the work of MIT physicist Marin Soljacic, and other scientists are giving it a thumbs up, not just for its feasibility or efficiency, but for its safety. According to Professor Peter Main at the Institute of Physics in UK, electromagnetic waves are harmless as long as they’re transferred at the right frequency. Unless you’re Wolverine, in which case you’re screwed.
WiTricity technology is more than...
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. In a transformer, an electric current running in a sending coil (or "primary winding") induces another current in a receiving coil (or "secondary winding"). The two coils must be very close together, and may even overlap, but the coils do not make direct electrical contact with each other. 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.
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.

**WiTricity technology is different than...**

**Radiative Power Transfer**

A microwave oven utilizes microwave radiation to cook food.

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

As mentioned at the beginning of this section, WiTricity 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.
gy is different than...

Magnetic Resonance Imaging (MRI)
RI machines use "magnetic resonance imaging" to produce diagnostic images of soft tissue.

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.

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...
WiTricity technology is different than... 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.
Features and Benefits

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.

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.

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 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 (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.

The image above shows how coils connected to a power source and to devices facilitate the transfer of electromagnetic waves that are then used to power the device. The technology is based on the work of MIT physicist Marin Soljacic, and other scientists are giving it a thumbs up, not just for its feasibility or efficiency, but for its safety. According to Professor Peter Main at the Institute of Physics in UK, electromagnetic waves are harmless as long as they’re transferred at the right frequency. Unless you’re Wolverine, in which case you’re screwed. Here’s a demo of WiTricity’s technology:
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.
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: 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.
ADVANTAGES AND DISADVANTAGES

ADVANTAGES

1) Get electricity anywhere without tumbling wires.
2) Nature of power delivery is Omni-directional i.e., in every direction.
3) Magnetic resonances are particularly suitable for everyday application because most of the common materials do not interact with magnetic fields, so the interactions with environmental objects are suppressed even further.
4) Highly resonant strong coupling provides high efficiency over distance.
5) Energy Transfer via magnetic near field can penetrate and wrap around obstacles.
6) Non-Radiative energy transfer is safe for people and animals.
7) Scalable design solutions from mill watts to kilowatts.
8) Flexible geometry allows WiTricity devices to be embedded into OEM.
9) No need of line of sight
10) No need of power cables and batteries
11) Does not interfere with radio waves
12) Wastage of power is small
13) Negative health implications
14) Highly efficient than electromagnetic induction
15) Less costly

DISADVANTAGES

1) At a rate of 10MHz, surely more people would be suffering from radio frequency radiation.
2) It is a basic law of physics, where energy is not destroyed, it is just got transferred.
3) For example, if you are using a mobile phone for about half an hour, surely you will get headache. Mobile phone transmit ea standard frequency of 2 MHz. Imagine what do if you are tagged to it daily.
4) Wireless power transmission can be possible only in few metres.
5) Efficiency is only 40%. As wisricity is in development stage, a lot of work is done for improving the efficiency and distance between transmitter and receiver.
6) The resonance condition should be satisfied and if any error exists, there is no possibility of power transfer.
7) If there is any possibility of very strong ferromagnetic material presence causes low power transfer due to radiation.
Conclusion

WiTricity, if successful will definitely change the way we live. Imagine cell phones, laptops, digital camera's getting self charged! Engineers have got job on hand to research and commercialize the technology. Till then, it is a wait in anticipation.
OSRAM SYLVANIA’s advanced luminaire concept is powered by a wireless power source developed by WiTricity. The pendant luminaire is suspended by non-conducting nylon lines, is a first of a kind demonstration of a wireless lighting fixture.

“General Electric awards WiTricity in its latest "ecomagination" challenge"

General Electric Co., the world’s largest maker of power-generation equipment, awarded $63 million to 10 companies developing solar, renewable energy, and cleantech technologies. WiTricity was selected as one of the winners of the GE ecomagination challenge for the energy savings achieved through wireless energy transfer.

“WiTricity and IHI to Develop Wireless Charging System for Electric Vehicles“

“Tokyo, Japan, June 15, 2011--- IHI Corporation and WiTricity Corporation of Watertown, MA have agreed to collaborate on the development of wireless charging systems for electric vehicles. In addition to collaborating on the development of wireless charging systems for electric vehicles, IHI also plans to apply the technology to industrial machinery to simplify installation and maintenance, by eliminating cumbersome electric power cables."

“Thoratec and WiTricity To Develop Wireless Powering of Implantable Heart Devices“

“PLEASANTON, CA ‘ Thoratec Corporation, a world leader in device-based mechanical circulatory support therapies to save, support and restore failing hearts, today announced a technology development agreement with WiTricity Corporation relating to WiTricity’s proprietary wireless resonant energy transfer technology for application in the field of mechanical circulatory support."

“Toyota and WiTricity Form Wireless Battery-charging Alliance“

“TOYOTA CITY, JAPAN ' Toyota Motor Corporation (TMC) has entered into a technological collaboration agreement with WiTricity Corporation concerning the practical application of automotive wireless charging systems and the promotion of their widespread use. TMC plans to participate in a WiTricity capital increase.”

“Delphi Showcases Innovative Wireless EV Charging“

“DETROIT ' Delphi Automotive has equipped an electric vehicle with its Delphi Wireless Charging System, a highly efficient wireless energy transfer system featuring technology developed by WiTricity Corporation. Delphi will display the test vehicle at this year’s SAE World Congress here this week."

“8 Things You Should Have Seen at CTIA 2011“

“Because the magnetic fields can pass electricity safely through humans, objects and concrete walls, someday we might have parking spots that can charge electric cars and desks and couches capable of juicing up your iPhone, iPad
and laptop while all three items sit unplugged in your briefcase."

“Power Unwired”
“Soljačić managed something that no one else had done before. He figured out how to separate the coils in a transformer to a distance greater than their size and have it continue to work, says Eric Giler, CEO of WiTricity”

“Delphi and WiTricity Developing Wireless Electric Car Charger”
“The auto supplier Delphi and a partner, the WiTricity Corporation, are developing a hands-free charging technology to transfer electricity over short distances without physical contact.”

“Delphi Working to Make Electric Vehicle Wireless Charging a Reality”
“TROY, Mich. - Delphi Automotive has reached an agreement with WiTricity Corp., a wireless energy transfer technology provider, to develop automatic wireless charging products for hybrid and electric vehicles. The collaboration between the two companies will help establish a global infrastructure of safe and convenient charging options for consumer and commercial electric vehicles.”

“Power from thin air”
“Wireless technology: It is already possible to send electricity without wires. Can devices be powered using ambient radiation from existing broadcasts? ANYONE whose mobile phone has ever run out of juice—which means, these days, more than half the world’s population—will like the idea of getting electrical power out of the air.”

“The Next Little Thing: Wireless Electricity”
“Marin Soljačić couldn't sleep. The problem was his wife's Nokia cell phone. The tyrannical device beeped on the bedside table when it needed to be plugged in. It could not be disabled. Instead of taking a hammer to the phone, Soljačić marveled at the fact that this device, and billions of others like it, was sitting a few feet away from all the electricity it could ever need. Why couldn't it receive power wirelessly, just as laptops get Wi-Fi?”

“The Massachusetts Technology Leadership Council announced the winners of the 2009 Technology Leadership Awards at its 12th annual Awards Gala yesterday evening at the Copley Marriot Hotel. These awards recognize the best and brightest technology innovators and leaders in the Bay State. Awards are given to companies and individuals that either develop or implement innovative technology solutions. The recognition highlights recent and significant contributions to companies or the broader industry.”

“The GoingGreen 100 Top Private Companies of 2009”
“With every industry and sector on earth in the midst of a green revolution, plenty of worthy candidates always present themselves for the GoingGreen 100. Adhering to the
usual criteria, our judges evaluated hundreds of companies. AlwaysOn Network recognized WiTricity as Energy Efficiency winner for the breakthrough potential of their technologies, market size, management team, and investors.”

Mass High Tech Names 2009 All-Stars of New England Innovation Economy

“WiTricity CEO, Eric Giler, was recognized as a leading technology executive and entrepreneur by Mass High Tech’s editorial staff. “The All-Stars honorees represent a broad range of technology and service sectors, including robotics, mobile technology, hardware, health care, materials, Internet and biotech. They stand as proof that innovation and growth in New England come in many forms, and technology leaders continue to emerge,” said E. Douglas Banks, editor of Mass High Tech.

“Wireless Power System Shown Off”

“A system that can deliver power to devices without the need for wires has been shown off at a hi-tech conference. The technique exploits simple physics and can be used to charge a range of electronic devices over many meters. Eric Giler, chief executive of US firm WiTricity, showed mobile phones and televisions charging wirelessly in Oxford. He said the system could replace the miles of expensive power cables and billions of disposable batteries.”

“Electricity Unplugged”

“In the near future, wireless electricity could replace the ubiquitous power cable. WiTricity co-founder, Aristeidis Karalis, looks at a revolutionary new way of transmitting power without wires.”

Wireless Electricity is Here (Seriously)

“Though WiTricity uses two coils — one powered, one not, just like eCoupled’s system — it differs radically in the following way: Soljačić’s coils don’t have to be close to each other to transfer energy. Instead, they depend on so-called magnetic resonance. Like acoustical resonance, which allows an opera singer to break a glass across the room by vibrating it with the correct frequency of her voice’s sound waves, magnetic resonance can launch an energetic response in something far away.”

Wireless Power Electrifies CES

“Perhaps the most promising wireless power technology is on display in a private suite high in the Venetian hotel tower. It’s the latest iteration of WiTricity, the Watertown, Mass.-based brainchild of MIT physicist Marin Soljačić.”

The Power to Overcome a Bad Economy

In a brick building in Watertown where men’s suits were once made, Eric Giler is running a company that seems to be defying the gravity of the current economic morass....

Giler Charged Up to be WiTricity CEO

By Efrain Viscarolasaga
Stealthy wireless power developer WiTricity Corp. in
Watertown has hired Brooktrout Technology Inc. co-founder and former Groove Mobile Inc. CEO Eric Giler as chief executive, adding a business presence to the company’s heralded MIT research team.

25 Awarded MacArthur ‘Genius’ Fellowships

Physicist Marin Soljačić is among 25 recipients of the MacArthur Foundation grant, awarded to “people working on the very edge of discovery and people at the edge of a new synthesis” ...

Durchbruch in der Elektrotechnik – Strom auf Schwingen (Breakthrough in Electrical Engineering – The Power of Resonance)

Dem US-Physiker Marin Soljacic ist es gelungen, elektrische Energie durch die Luft zu übertragen. Nun steht die Industrie bei ihm Schlange. Eine Reportage von Martin Kotynek...

TR10: Wireless Power

Technology Review presents 10 technologies that we think are most likely to change the way we live. Physicist Marin Soljačić is working toward a world of wireless electricity...

Wireless Energy

The M.I.T. physicist Marin Soljacic found inspiration for his latest invention in the dying batteries of his wife’s cellphone. Every morning around 2 her phone would beep loudly. “One night it occurred to me, wouldn’t it be great if this thing took care of its own charging?” he says. The question was how to transfer energy wirelessly...

Wireless energy promise powers up

By Jonathan Fildes
Science and technology reporter, BBC News
A clean-cut vision of a future freed from the rat’s nest of cables needed to power today’s electronic gadgets has come one step closer to reality.

Wireless Energy Lights Bulb from Seven Feet Away

If you thought wireless Internet made life convenient, try wrapping your mind around wireless power...

Das Ende der Strippe (The End of the Wire)

Ein Preis von 3000 Dollar winkte dem, der es schaffen würde, »einen Luftschiffmotor mit Energie anzutreiben, die durch den Raum übertragen wird«. Der drahtlose Strom sollte 30 Meter überbrücken und eine Leistung von 75 Watt liefern....
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