WIRELESS POWER TRANSMISSION

AN OVERVIEW OF TECHNOLOGICAL ADVANCEMENTS

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Abstract— Most of the developments in today's world would have been impossible without the existence of electricity. The main mode of transmission of this electrical energy available to all of us is through wires but efficiency is significantly reduced in power transmission through wires. Only 71% of the electrical energy can be transferred efficiently. Moreover it is always difficult to lay cables in remote area. All these factors have given rise to necessity of a concept where the losses are minimized and convenience of energy transfer is increased. The concept being wirelessly transmitting power i.e. Witricity. In this paper we have given an overview of the recent researches and advancement in the field of wireless transmission of electricity. Various methods of wireless power transfer such as laser beaming, microwave power transfer, solar and magnetic resonant induction coupling are explained. We have also discussed the future aspects of wireless power transmission and have stated its various advantages. This paper helps us in understanding thoroughly the alternative method of transmission of power.

Keywords—Witricity,MIT, Nikola Tesla, Wireless Energy Transfer, Microwave Power Transfer.

I. INTRODUCTION

One of the major issue in power system is the losses occurs during the transmission and distribution of electrical power. As the demand increases day by day, the power generation increases and the power loss is also increased. The major amount of power loss occurs during transmission and distribution. The percentage of loss of power during transmission and distribution is approximated as 26%. The main reason for power loss during transmission and distribution is the resistance of wires used for grid. The efficiency of power transmission can be improved to certain level by using high strength composite over head conductors and underground cables that use high temperature super conductor. But, the transmission is still inefficient. Mid-range means that the separation between the two objects affecting the transfer should be of the order of a few times the characteristic sizes of the objects. This implies that one source could be used to power or recharge all portable devices within an average sized room. In future it can be used to charge phones or laptops signing into a power zone. This technology can be established in similar way as Wi-Fi technology is capturing the market now. [8]

II. TESLA COIL

A Tesla coil is a category of disruptive discharge transformer coils, named after the inventor, Nicola Tesla. Tesla coils are composed of coupled resonant electric circuits. It is a special transformer that can take the 110v electricity from our house and capable of converting it rapidly to a great deal of high-voltage high–frequency, low amperage power. The high frequency output of even a small Tesla coil can light up fluorescent tubes held several feet away without any wire connections. The high frequency high-voltage energy produced possesses qualities unlike conventional electricity. It defies most insulation material , transmits energy without wires , produces heat , light , and noise yet harmlessly passes through human tissue with virtually no feeling or shocking effects.

Some of Tesla's later coils were considerably larger and operated at much higher power levels. Tesla coils achieve great gain in voltage by loosely coupling two resonant LC circuits together, using an air-core (ironless) transformer. Tesla coils' voltage gain is proportional to the square root of the ratio of secondary and primary inductances. Later coil types are an air-core, dual-tuned resonant transformer that generates very high voltages at radio frequencies.[17]

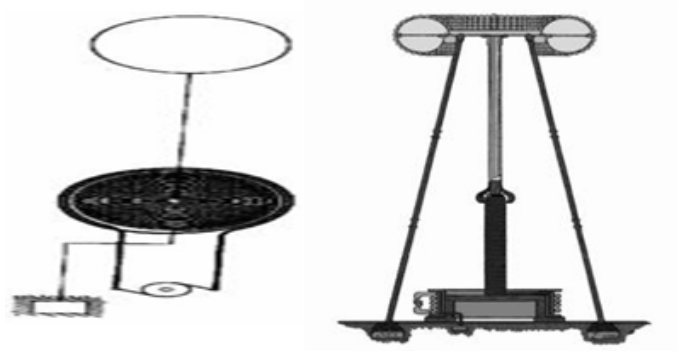

Fig. 1. Tesla Coils[17]

A. Power Consumption of Tesla Coil

- Power Supply -Initially, in circuit the upto ±170 V is applied to the inverter. Then a step-up transformer (240/2400 transformer) is to be used ahead of the inverter. A factor of ten (10(±170) = ±1700 V) gave us enough range. This is an oil filled transformer, called a pole pig and was rated at 5kVA, so the rated input current is 5000/240 = 20.8 A. This is a very conservative rating, for continuous operation (run four hours at 30 A without a problem) in a 40°C ambient.

B. Calculations: During inverter operation, each resistor carries 1/4 of the total supply voltage while its IGBT is off, and 0 while its IGBT is on. The power dissipation for a total voltage of 3400 V is P = V^2 / R =(3400 / 8)^2 / 430000 = 0.42 W during the off period, and double this amount, or 0.84 W during inverter operation.

III. WI-EY

An A new era of wireless technology has been started. 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 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 technology is called 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. Even better, because of witricity

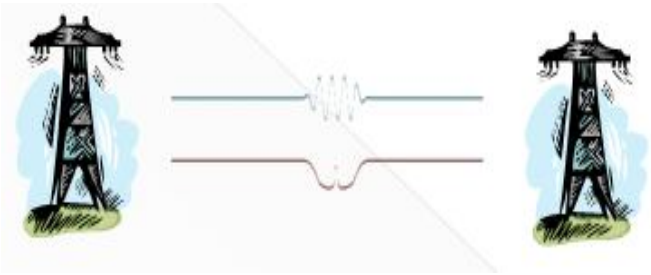

Fig. 2. Witricity

IV. WIRELESS ENERGY TRANSFER

It is the transmission of electrical energy from a power source to an electrical load without interconnecting conductors. Contactless transmission is useful in cases where interconnecting wires are inconvenient, hazardous, or impossible. The problem of contactless power transmission differs from that of wireless telecommunications, such as radio. In the latter, the proportion of energy received becomes critical only if it is too low for the signal to be distinguished from the background noise. With inductive power, efficiency is the more significant parameter. A large part of the energy sent out by the generating plant must arrive at the receiver or receivers to make the system economical. Different methods of energy transfer are:

A. Electromagnetic induction: Energy transfer by electromagnetic induction is typically magnetic but capacitive coupling can also be achieved. As in fig.3 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 reverses its direction

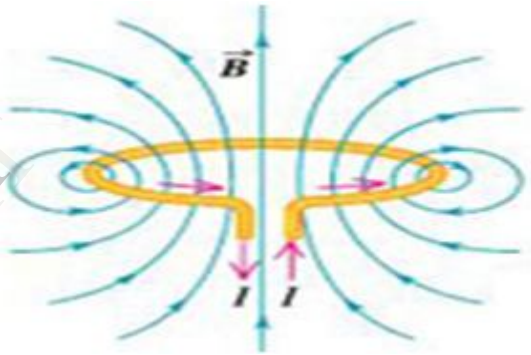

Fig. 3. Electromagnetic induction[16]

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

C. Laser method: In the case of electromagnetic radiation closer to visible region of spectrum (10s of microns (um) to 10s of nm), power can be transmitted by converting electricity into a laser beam that is then pointed at a solar cell receiver, This mechanism is generally known as "power beaming" because the power is beamed at a receiver that can convert it to usable electrical energy.

V. FIELDS OF TRANSMISSION

According to the usage of the technology of the wireless we divide the type transmission through far field and near field. Near field transmission- In this transmission process the gadgets which are used in the day to day life comes into concept for the near field concept, example: charging of mobile phones etc. Far field transmission- In this transmission concept the wireless transmission of power can be given to any home appliances, example-power given in running the television and other home appliances.

The most simple and common example of acoustic resonance is shattering of a wine glass by an opera singer. When identical wine glasses are filled with different quantity of wine, they each have different resonance frequencies. Now, when an opera singer sings and a certain voice pitch matches the resonant frequency of a specific glass, the acoustic energy accumulated by the glass is sufficient for it to explode, while other glasses remain unaffected**.** Thus, there exists a strongly coupled regime in all systems of coupled resonators and highly efficient energy transfer is achieved when operated in this regime [6]. Since WiTrcity operates in a non-radiative field, there is an advantage that even if the receiving coil does not pick up all the power, the residual power remains in the vicinity of the sending coil and is not lost in the environment due to radiation. The WiTricity circuit is designed in a way that the frequency of the alternating current is increased to the resonant frequency. The travelling current induces magnetic and electric fields in the inductor and capacitor loops respectively which extends up to 5 meters around the device. This magnetic field induces an electric current in the inductor loop of any mobile gadget having the receiver coil with the same resonant frequency. Thus both the circuits resonate together and energy transfer is achieved [15].

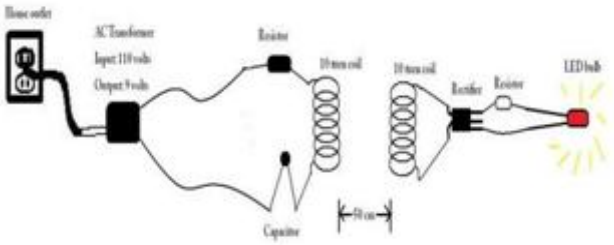

Fig. 4. Witricity system for power transmission[15]

As can be seen from the diagram, it uses two coils which are tuned at the same resonant frequency [1]. The main supply is given to transformer which induces high frequency AC on the primary coil. When secondary coil comes in the vicinity of the primary coil, power gets transferred from primary to secondary. Power transfer takes place as high frequency gets induced on the secondary coil. The signal at the secondary coil is rectified and given to the load.Something the MIT team realized is that if evanescent tails (tails of energy) are made larger than the size of the objects, energy could be conserved and energy lost due to radiation will be less. This is something that they did differently from many previous tests, because most of the time, long evanescent tails lead to higher interference between the devices. [8]

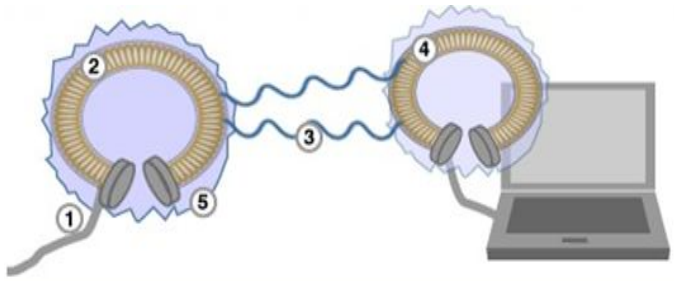

Fig. 5. Working of wireless power transfer system[18]

Fig. 5 working can be explained as first the power from mains to antenna, which is made cf copper then antenna resonates at a frequency of about 6.4MHz producing electromagnetic waves and 'Tails' of energy from antenna 'tunnei' up to 5m (16.5ft) then electricity picked up by laptop's antenna, which must also be resonating at 6.4MHz. Energy used to re-charge device. Energy not transferred to laptop re-absorbed by source antenna. People/other objects not affected as not resonating at 6.4MHz ,The transmitter and receiver circuit combined is called the coupling circuit. It is the heart of the entire system as the actual wireless power transfer is carried out here. The efficiency of the coupling circuit determines the amount of power available for the receiver system[17].

VI. MERITS AND DEMERITS

A. MERITS:

- Less costly -components of transmitter and receivers are cheaper. So this system is less costly.
- Less accidents and instances of electrocution.
- Convenient to consumers who use products that can be charged through Witricity.
- Eliminate the need for an inefficient, costly, and capital intensive grid of cables, towers and substations.
- Gateway to other breakthrough technological advances.

- Our home would keep your gadgets constantly powered up.
- Eliminate batteries for the back-up power.
- Highly Resonant Strong Coupling Provides High Efficiency Over Distance

B. DEMERITS:

- Products we use on the go would still need batteries.
- Could be like Wi-Fi: free in some places and fees in others
- Electrical pollution.
- Associated with illnesses such as, cardiac problems, learning disabilities, mood disorders, and fatigue.
- Associated with childhood and adult leukemia, breast cancer, clinical depression, and miscarriage.

VII. CONCLUSION

Witricity technology is a non-radiative mode of energy transfer, relying on the magnetic near field. Magnetic fields interact very weakly with biological organisms-people and animals- and are scientifically regarded to be safe. Witricity products are being designed to comply with applicable safety standards and regulations. Hence Witricity is technology safe. witricity can transfer power depends on the source and receivers. if it is relatively close to one another, and can exceed 95%.Efficiency is primarily determined by the distance between the power source and capture device, however, the shape may impact the efficiency. It can transfer the power through walls also. Traditional magnetic induction requires that the power source and capture device be very close to one another usually within millimeters to transfer power efficiently. Witricity is a convenient and cost effective technology as it will help minimize the use of plastic and copper used in electric devices this new technology has tremendous merits like high transmission integrity and low loss. As the resonant frequency gets tighter, the energy transferred to other objects drops away. With improved efficiency and range, this technology will change the way we look at energy transfer.

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