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Wireless Electricity Transmission Fuel for Future Development

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Abstract: ***This paper presents the concept of transmitting electricity without use of wires. Transmission of electricity wirelessly from one place to another reduces the transmission and distribution losses. Using this technology efficiency can be achieved up to 90% [1]. Various techniques which support the ideas of implementing the technology have been covered. Various research evidences have been discussed. A new idea of receiving wireless electricity at consumers' level has been mentioned. Energy can be received as discrete signals for fast processing these signals can be converted to continuous signals using set up box or same signal can be used depending on our need. With the merge of sensor technology with this idea human can have the comfort life in near future. Solar power satellite system expected to realize around 2030[2]. Imagine a future in which wireless power transfer is feasible: cell phones, household robots, mp3 players, laptop computers and other portable electronics capable of charging themselves without ever being plugged in, freeing us from that final, ubiquitous power wire. For our convenience we term the energy at generating end as Electricity and receiving end as Photricity. Some of these devices might not even need their bulky batteries to operate. Applications, advantages, and challenges for implementing this concept have also been discussed.***

Keywords: Photricity, Direct wireless power (DWP), solar power satellite (SPS), TESLA, RECTENNA

1. 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.

Wireless power transmission is the transmission of electrical energy from a power source to an electrical load without interconnecting wires. A large part of the energy sent out by the generating plant must be optimally received at the end. The percentage of loss of power during transmission and distribution is approximated as 27% [3]. 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 made up to 90% using this wireless transmission system. According to the World Resources Institute (WRI), India's electricity grid has the highest transmission and distribution losses in the world – a whopping 27%. Numbers published by various Indian government agencies put that number at 30%, 40% and greater than 40% [4]. This is attributed to technical losses (grid's inefficiencies) and theft.

Nicola Tesla "father of wireless", based on Tesla Theory, tried to transmit the electrical energy across a large distance and receive it at the destination with negligible losses [5]. There have been series of researches and experiments performed to take this very technology into reality. There are number of technologies that would be possibly used as a means to felicitate the electrical power transmission without wires.

2. Concept of Wireless Electricity Technology

It mainly works on the concept of magnetic resonance. Resonance phenomena are the natural frequency at which energy can most efficiently be added to an oscillating system. It exists in most of the physical systems. When the resonant frequency is found it vibrates with higher energy. But the resonant magnetic coupling occurs when the natural frequencies of two becomes approximately equal[6].

2.1 Wireless Electricity Transmission System

This concept is applicable for small and large distances area. Now we are discussing the ideas for transmitting the energy wirelessly.

2.1.1 The System for Transmission Over Large Distance

William C.Brown designed a model for transmitting the energy wirelessly over larger area. This system is mainly divided into three sections. First one is the conversion of energy into microwave and then transfer the wave through rectenna (rectifier and antenna) from the transmitter and received at the receiver which will be converted into the conventional electrical power [7].

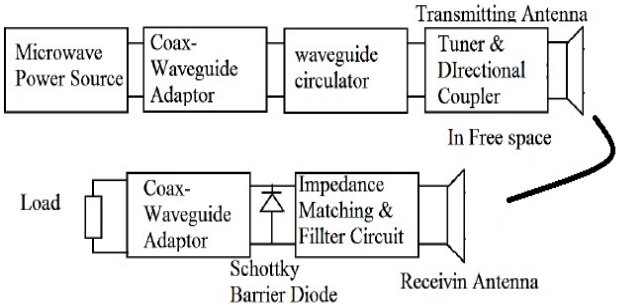


Figure 1: Block diagram for wireless electricity transmission system for large distances [14]

In the transmission side, the microwave power source generates microwave power and the output power is controlled by the electronic control circuits. The wave guide ferrite circulator which protects the microwave power source from reflected power is connected with the microwave power source through the Coax-waveguide adaptor. The

tuner matches the impedance between the transmitting antenna and the microwave source. The attenuated signals will be then separated based on the direction of signal propagation by directional coupler. The transmitting antenna radiates the power uniformly through free space to the antenna [8]. In the receiver, an antenna receives the transmitted power and converts the microwave in DC power. The impedance matching circuit and filter is provided to set the output impedance of a signal source equal to the rectifying circuit. The rectifying circuit consists of Schottky barrier diodes which convert the received microwave power into DC power [8]. Due to atmospheric attenuation and absorption frequencies above 6 GHz is not efficient and the frequency below 2 GHz require excessively large aperture for transmission and reception. Therefore the suitable range of frequencies are in the range of 2-6 GHz. Microwave transmission often uses 2.45GHz or 5.8GHz of ISM band [9].

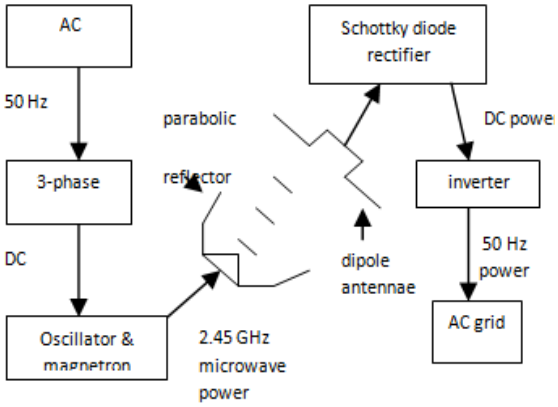


Figure 2: The wireless electricity transfer process through microwaves [15]

2.1.2 For Small Distances

For this first we need an oscillator, which would provide the carrier signal with which to transmit the power. Oscillators are not generally designed to deliver power, thus it was necessary to create a power amplifier to amplify the oscillating signal. The power amplifier would then transfer the output power to the transmission coil. Next, a receiver coil would be constructed to receive the transmitted power. However, the received power would have an alternating current, which is undesirable for powering a DC load. Thus, a rectifier would be needed to rectify the AC voltage to output a clean DC voltage. Finally, an electric load would be added to complete the circuit design

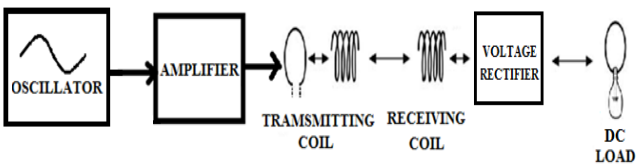


Figure 3: Operational diagram for wireless electricity transmission system for small distances [10]

Oscilattor provdes carrier signls, In order to generate the maximum amount of flux which would induce the largest voltage on the receiving coil, a large amount of current must be transferred into the transmitting coil. 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 [10].

3. About The Concept

Wireless electricity transmission system can be used in collaboration with existing technology that is sensors. For this, firstly the generated electricity frequency can be brought up to the range of microwave. This microwave energy can be transmitted from transmission end. Then this energy will be received at sub-station. Now from here it will be sent to consumers, who will be a part of receivers end. This energy can be received by consumers houses in small packets form, i.e. As discrete signals not continuous, these packets can be trapped by wireless hub installed at each home, after that these signals will be processed by wall mounted set-top box/wireless hub, which will convert these signals as continuous signals. We term the energy at generating end as Electricity and receiving end as Photricity. This approach will also help to keep a watch on consumers' usages details regularly. Also they will have exact details of connected load every instant of time. Sensing system can be employed for smooth continuation of this system. For example, consider a particular area where the load varies continuously from time to time, i.e. at night time load is low in comparison to evening time. So sensing system can govern this fluctuation accordingly. Equipment can be put on automatic mode using sensing technique, which will judiciously take the required power when and where it will be needed here we can merge this concept with sensor technology which will keep track for useful utilization of electricity. As sensor technology can sense when to utilize the electricity and when not. Further we can apply the concept of Internet to apply to broader area.

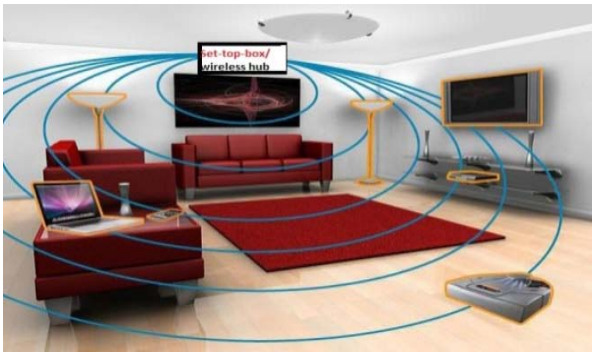
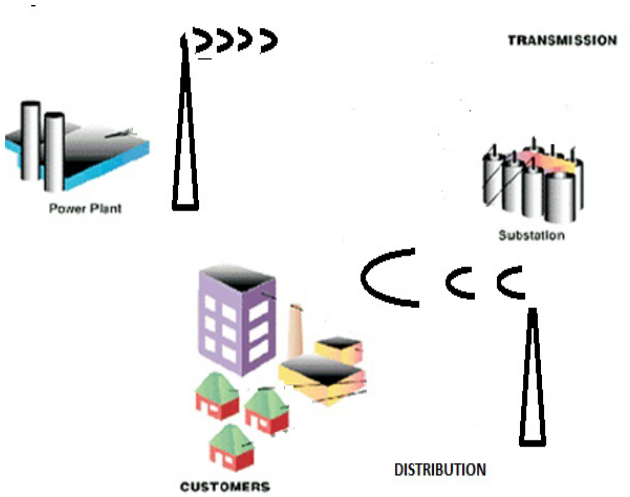


Figure 4: Model for above cited concept

3.1 Implementing on Small Scale



According to our observation and sources available to us, we can save a huge amount just by implementing this idea at various institutions and schools. And contribute toward the development of nations.

4. Applications

The technology for wireless energy transmission is in the forefront of electronic development and is a fuel for future development. This technology can be used as "Direct Wireless Power" (DWP) the need of the electrical energy of the devices can be fed directly by embedding receiver on various devices. Thus by using DWP our devices never runs out of battery, become more reliable, convenient and environment friendly [12]. Since the waves can be received from any part of the globe our world will never dream in darkness. Geographical terrors will not restrict the energy flow. This technology can also be used to automatically recharge the electric vehicles, space crafts and satellites. The industries can use the wireless energy for any purpose. Their reliability in inefficient wired energy can be eliminated. SPS[13] is another application of this technology. It consists of mainly three segments; solar energy collector to convert the solar energy into DC electricity, DC-to-microwave converter, and large antenna array to beam down the microwave power to the ground.

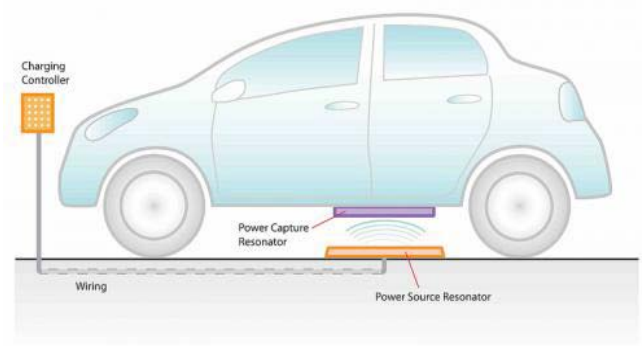


Figure 5: automatic recharge systems for electric moving vehicles [16]

4.1 Advantages

The WET would eliminate the high-tension power transmission line cables, towers and substation, which are seen as not very efficient way of energy transmission. This will easily lead to the global scale connectivity of power system. Thus the cost of transmitting and receiving the energy becomes less expensive thereby reducing the tariff rate. Since here we do not use cable, electricity would be reached to any places irrespective of the geographical situations. Loss of power through transmission is negligible thus this method is more efficient. The natural hazards like earthquake, landslides, flood and others cannot cut the power as long as the WPT system operates thereby reliability is more compared to the wired transmission of energy [14]. The power failure due to short circuit, fault in the cable lines would never occur. The receiver can be embedded to any electrical devices and appliances that it need not use battery. The portability of the electrical devices increases.

4.2 Challenges

Initial cost is very high for its practical implementation. Since microwave is used interference is high. Biological effects associated with the wireless transmission of electricity due to the high, Frequency microwave signals are the main challenges of this technology. Thus the public exposure of WPT fields would be below existing safety guidelines (ANSI/IEEE exposure standards)[14]. Since the energy is freely in the air energy theft will occur.

5. Conclusions

This concept offers greater possibilities for transmitting power with negligible losses and ease of transmission than any invention or discovery heretofore made. We don't need cables, pipes, or copper wires to receive power. We can send it to you like a cell phone call – where you want it, when you want it, in real time. We can expect with certitude that in next few years' wonders will be wrought by its applications if all the conditions are favorable.

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