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Wireless Power Transmission Via Solar Power Satellite

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ABSTRACT:
Electricity is the most versatile and widely used form of energy. The global demand for electricity is continuously growing. Of the total generation worldwide, more than 60 per cent of energy is generated using coal-fired station resulting in carbon dioxide emission threatening the global warming. To mitigate the consequence of climate change, generation systems need to undergo significant changes. Wireless Power transmission (WPT) is a useful and convenient technology that can be employed to collect solar energy and concentrate on earth surface without the need for a wire connection called a Solar power satellites (SPS). This paper concentrates mainly on (i) The most popular concept known as Tesla Theory, (ii) The microwave power transmission(MPT) called Solar power satellite, and (iii) The highly efficient fibre lasers for wireless power transmission.
KEYWORDS:- *Wireless Transmission, Tesla Theory, Microwave Power Transmission*

I. INTRODUCTION:

In this paper, we present the concept of transmitting power wirelessly to reduce transmission and distribution losses. The wired distribution losses are 70-75% efficient. We cannot imagine the world without electric power which is efficient, cost effective and produce minimum losses is of great concern. This paper tells us the benefits of using WET technology specially by using Solar based Power satellites (SBPS) and also focuses that how we make electric system cost effective, optimized and well organized. Moreover,

attempts are made to highlight future issues so as to index some emerging solutions. The present electricity generation system is not very efficient in terms of energy transfer. About 20 to 30% energy is lost during the distribution of the electricity. Therefore the scientists are working on the projects to improve the ultimate electricity supply. Scientists are looking for alternate and efficient technologies to provide 100% electricity transfer. The change and development in the various fields have brought more client satisfaction and output. Therefore the wireless transmission of electricity is also on move [1].

II. WIRELESS ELECTRICITY TRANSMISSION (WET) TECHNOLOGY:

Wireless power transmission [4, 5] is a process that takes place in any type of system in which electrical current is conveyed from a power source to an electrical load. What makes this process unique is that there is no usage of any type of wiring to connect the system to a source of power. Wireless electricity (Power) transmission basically is the transmission of electricity with the help of microwaves and there is no need to use cables, towers and grid stations [4,5]. There are three methods or approaches which can be developed. These are as given below:

2.1. Short range (Induction):-

This ranges few centimeters e.g. transformer in which transfer takes place due to mutual induction [4,5].

2.2. Moderate range (Adaptive Inductive Coupling):

Witricity [2] (Adaptive Inductive Coupling)wireless power transfer technology can be used to charge the electronic objects automatically. The ability of our technology to transfer power safely, efficiently, and over distance can improve products. This principle of wireless electricity works on the principle of using coupled resonant objects for the transference of electricity to objects without the use of any wire [4,5].

Working of Wireless Electricity:-

1. Power from mains to antenna, which is made of copper
2. Antenna resonates at a frequency of about 10MHz, 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 10MHz. Energy used to re-charge device

5. Energy not transferred to laptop re-absorbed by source antenna. People/other objects not affected as not resonating at 10MHz Figure 1.Working of Wireless Electricity.

III. METHODS OF WIRELESS POWER TRANSMISSION OF ELECTRICAL POWER:

3.1 Induction:

The principle of mutual induction between two coils can be used for the transfer of electrical power without any physical contact in between. The simplest example of how mutual induction works is the transformer, where there is no physical contact between the primary and the secondary coils. The transfer of energy takes place due to electromagnetic coupling between the two coils.

3.2 Electromagnetic Transmission:-

Electromagnetic waves can also be used to transfer power without wires. By converting electricity into light, such as a laser beam, then firing this beam at a receiving target, such as a solar cell on a small aircraft, power can be beamed to a single target. This is generally known as "power beaming".

3.2 Evanescent Wave Coupling:-

Researchers at MIT believe they have discovered a new way to wirelessly transfer power using non-radiative electromagnetic energy resonant tunneling. Since the electromagnetic waves would tunnel, they would not propagate through the air to be absorbed or wasted, and would not disrupt electronic devices or cause physical injury like microwave or radio transmission. Researchers anticipate up to 5 meters of range.

3.3 Electrodynamics Induction:-

It is also, known as "resonant inductive coupling" resolves the main problem associated with non-resonant inductive coupling for wireless energy transfer, specifically, the dependence of efficiency on transmission distance. When resonant coupling is used, the transmitter and receiver inductors are tuned to a mutual frequency and the drive current is modified from a sinusoidal to a non-sinusoidal transient waveform. Pulse power transfer occurs over multiple cycles. In this way, significant power may be transmitted over a distance of up to a few times the size of the transmitter.

3.4 Radio and Microwave:-

Power transmission through 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.

3.5 Electrostatic Induction:-

Electrostatic Induction also, known as 'capacitive coupling' is an electric field gradient or differential capacitance between two elevated electrodes over a conducting ground plane for wireless energy transmission involving high frequency alternating current potential differences transmitted between two plates or nodes.

3.6 Microwaves:-

Microwaves [3] are electromagnetic waves with wavelengths ranging from as long as one meter to as short as one millimeter, or equivalently, with frequencies between 300 MHz (0.3 GHz) and 300 GHz. For Wireless power transfer we use high power microwaves namely 1-10GHz radio-waves [3, 4, 8].

IV. CURRENT TECHNOLOGY IN THE FIELD OF WIRELESS POWER TRANSMISSION:

4.1 Microwave Transmitter:

The most current research and proposals use microwaves as the frequency range of choice for transmission. At present an efficiency of 76 per cent is possible using current technology for microwave power transmission. For transmission efficiency, the waves must be focused so that all the energy transmitted by the source is incident on the wave collection device. Higher frequencies are also impractical because of the high cost of transmitters and the relative low efficiency of current optical and infrared devices. The microwave transmitting devices are classified as Microwave Vacuum Tubes (magnetron, klystron) and Microwave Power Module (MPM)) and Semiconductor Microwave transmitters and amplifiers (GaAs MESFET, SIC MESFET, HFET, and InGaAs). Cooker type Magnetron is widely used for experimentation of WPT. Microwave power transmission (MPT) [7, 9] is the use of microwaves to transmit power through outer space or the atmosphere without the need for wires. It is a sub-type of the more general wireless energy transfer methods. Microwaves are widely used for point-to-

point communications because their small wavelength allows conveniently-sized antennas to direct them in narrow beams, which can be pointed directly at the receiving antenna [4, 5]. This allows nearby microwave equipment to use the same frequencies without interfering with each other, as lower frequency radio waves do. Microwave Power transfer (MPT) [2.45 GHz or 5.8GHZ) of ISM band is used. (ISM= Industry, Science and Medical).

4.2 Use of Microwave Power Transmission in

Solar Power Satellites (SPS):-

Solar power generating satellites launched into space and transmitting power to Earth stations. This idea was first proposed in 1968 and all of the experiments have only been carried out in terrestrial laboratories. This task is often completed by using solar power satellite (SPS) [6, 7], placed in high earth orbit. This satellite converts the sunlight into energy; this energy is composed of microwaves. These microwave signals are transmitted to an antenna on ground/Main grid station (MGS), From MGS these waves are transferred to BGS (Base grid station) so called rectenna which convert microwaves into DC electricity. There will be energy receiver box or energy router in each home. The information of the electricity or power required for each home will be available with the grid station. At the grid station the electricity will be converted into energy packets likewise internet data packets and the header of that energy packet will include the address of the energy receiver that is mounted on the wall of the house of consumer. The energy packet will then reach the energy receiver and will be stored in that energy receiver after that the consumer can use that stored energy any time he wants. We used the same concept as we do in telecom sector and through this act we can buy electricity according to our need.

4.3 Solar Power Satellite:

Space-based solar power (SBSP) [6, 7] is the concept of collecting solar power in space for use on Earth. It has been in research since the early 1970s. SBSP also introduces several new hurdles, primarily the problem of transmitting energy from orbit to Earth's surface for use. SBSP designs generally include the use of some manner of wireless power transmission. It mainly consists of three segments Solar energy collector (To convert Solar energy into DC current), DC to microwave converter and Large antenna array to beam down (Microwave) power to ground [6, 7]. Solar energy collector (Photovoltaic cell, solar thermal turbine). DC to microwave converter (Microwave tube system and/semiconductor system) Antenna SPS will be expected to operate in 2025-2030. The first solar collector can be either photovoltaic cells or solar thermal turbine. The second DC-to-microwave converter of the SPS can be either microwave tube system or semiconductor system. It may be their combination. The third segment is a gigantic antenna array. An amplitude taper on the transmitting antenna is adopted in order to increase the beam collection efficiency and to decrease sidelobe level in almost all SPS design. A typical amplitude taper is called 10 dB Gaussian in which the power density in the center of the transmitting antenna is ten times larger than that on the edge of the transmitting antenna.

4.4 Antennas for Microwave Power Transmission:

All antennas can be applied for both the MPT system and communication system, for example, Yagi-Uda antenna, horn antenna, parabolic antenna, microstrip antenna, phased array antenna or any other type of antenna. To fixed target of the MPT system, usually large parabolic antenna selected in MPT demonstration in 1975 at the Venus Site of JPL Goldstone Facility and inground-to-ground MPT experiment in 1994-95 in Japan. In the fuel-free airship light experiment with MPT in 1995 in Japan, they changed a direction of the parabolic antenna to chase the moving airship. However, we have to use a phased array antenna for the MPT from/to moving transmitter or receiver which include the SPS because we have to control a microwave beam direction accurately and speedy. Power distribution at the transmitting antenna is given by $(1\text{-}r^2)$, where r is the radius of antenna. The phased array is a directive antenna which generates a beam form whose shape and direction by the relative phases and amplitudes of the waves at the individual antenna clements. It is possible to steer the direction of the microwave beam. The antenna elements might be dipoles, slot antennas, or any other type of antenna, even parabolic antennas

V. LATEST INVENTION &EXPERIMENTS (WITRICITY):

The new technology called WiTricity is based on using coupled resonant objects. Two resonant objects of the same resonant frequency tend to exchange energy efficiently, while interacting weakly with extraneous off-resonant objects. After Nicolas Tesla, there was rebirth of this in 2007 by the team from Massachusetts Institute of Technology, who call their invention 'WiTricity'. In the first successful trial of its kind, the team was able to illuminate a 60-watt light bulb 7ft away. They simulated a transfer of 60W across two identical loops similar in dimension. The coils had a radius of 30 cm, with a cross section of 3cm and distance between the coils was 200m. Basic principle is two resonant objects of the same resonant frequency tend to exchange energy efficiently, while interacting weakly with extraneous off-resonant object. The investigated design consists of two copper coils, each a self-resonant system. One of the coils, attached to the power source, is the sending unit. The resonant nature of

the process ensures the strong interaction between the sending unit and the receiving unit, while the interaction with the rest of the environment is weak.

VI. MERITS, DEMERITS AND APPLICATIONS:

6.1. Merits:

Remove physical infrastructure "Grids and Towers" [1]. Cost effective (Remove cost of towers and cables). During rain and after natural disaster it is often hard to manage cables and towers so it removes this. Losses during transmission and distribution can be removed. Microwaves (electricity) are more environments friendly. It does not involve emission of carbon gases. Electricity bills using conventional supply can be cut to very low. Zero fuel cost [1].

6.2. Demerits:

Biological effects associated with the wireless transmission of electricity due to the high frequency microwave signals is the first demerit of this technology [1, 7].
This project is a onetime expense but it involves a lot of initial expenditure. It is expected that the price of receive electricity through this technology would decline overtime [7].
This technology is limited to the use of few technologies like solar satellites and Tesla grid.
The transmission of electric current through this mode is susceptible to security risks like cyber war fare [1].

VII. CONCLUSION:

The concept of Microwave Power transmission (MPT) and Wireless Power Transmission system is presented. The technological developments in Wireless Power Transmission (WPT), the advantages, disadvantages, biological impacts and applications of WPT are also discussed. This concept offers greater possibilities for transmitting power with negligible losses and ease of transmission than any invention or discovery heretofore made. Dr. Neville of NASA states "You 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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