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A paper presentation

On

WITRICITY

Wireless transmission of electricity

Development & Possibility

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***Abstract –***

***In the present paper the various technologies available so far for wireless transmission of electricity and the need for a Wireless System of Energy Transmission is being discussed to find its possibility in actual practices, their advantages, disadvantages and economical consideration. This paper is mainly concentrated on:***

1. ***The most popular concept known as Tesla Theory,***
2. ***The microwave power transmission (MPT) called Solar power satellite, and***
3. ***The highly efficient fibre lasers for wireless power transmission.***

 ***Many concepts, research papers, patents are available on wireless transmission of electricity but the commercial technologies are yet to be materialized. The paper also discusses the possible ways to get useful and practical results out of all research carried out so far elsewhere.******The advantages, disadvantages, biological impacts and applications of WPT are also presented.***

**I. INTRODUCTION**

In our present electricity generation system we waste more than half of its resources. Especially the transmission and distribution losses are the main concern of the present power technology. Much of this power is wasted during transmission from power plant generators to the consumer. The resistance of the wire used in the electrical grid distribution system causes a loss of 26-30% of the energy generated. This loss implies that our present system of electrical distribution is only 70-74% efficient. We have to think of alternate state - of - art technology to transmit and distribute the electricity. Now- a- days global scenario has been changed a lot and there are tremendous development in every field. If we don’t keep pace with the development of new power technology we have to face a decreasing trend in the development of power sector. The transmission of power without wires may be one noble alternative for electricity transmission.

**II. THE TECHNOLOGIES AVAILABLE**

 **I**n this remarkable discovery of the "True Wireless" and the principles upon which transmission and reception, even in the present day systems, are based, Dr. Nikola Tesla shows us that he is indeed the "Father of the Wireless." The most well-known and famous Wardenclyffe Tower (Tesla Tower) was designed and constructed mainly for wireless transmission of electrical power, rather than telegraphy [1]. The most popular concept known is Tesla Theory in which it was firmly believed that Wardenclyffe (Fig.1) would permit wireless transmission and reception across large distances with negligible losses [2]. In spite of this he had made numerous experiments of high quality to validate his claim of possibility of wireless transmission of electricity (Fig.2). But this was an unfortunate incidence that people of that century was not in a position to recognise his splendid work otherwise today we may transmit electricity wirelessly and will convert our mother earth a wonderful adobe full of electricity.



Fig.1. The 187-foot Wardenclyffe Tower (Tesla Tower) in 1903. This was to be the first broadcasting system in the world. Tesla wanted to transmit electricity from this Tower to the whole globe without wires using the Ionosphere. The source of the transmitted electricity was to be the Niagara Falls power plant[1].

 The modern ideas are dominated by microwave power transmission (MPT, Figure 3) called Solar power satellite to

be built in high earth orbit to collect sunlight and convert that energy into microwaves, then beamed to a very large antenna on earth, the microwaves would be converted into conventional electrical power.



Fig.2. The basis for Tesla’s system for the wireless transmission of electrical power[3].

 William C. Brown, the leading authority on wireless power transmission technology, has loaned this demonstration unit to the Texas Space Grant Consortium to show how power can be transferred through free space by microwaves. A block diagram of the demonstration components is shown below. The primary components include a microwave source, a transmitting antenna, and a receiving rectenna.



Fig.3 .Microwave power transmission [4].

 The microwave source consists of a microwave oven magnetron with electronics to control the output power. The output microwave power ranges from 50 W to 200 W at 2.45

GHz. A coaxial cable connects the output of the microwave

source to a coax-to-waveguide adapter. This adapter is connected to a waveguide ferrite circulator which protects the

microwave source from reflected power. The circulator is connected to a tuning waveguide section to match the waveguide impedance to the antenna input impedance. The slotted waveguide antenna consists of 8 waveguide sections with 8 slots on each section. These 64 slots radiate the power uniformly through free space to the rectenna. The slotted waveguide antenna is ideal for power transmission because of its high aperture efficiency (> 95%) and high power handling capability.

 A rectifying antenna called a rectenna receives the transmitted power and converts the microwave power to direct current (DC) power. This demonstration rectenna consists of 6 rows of dipoles antennas where 8 dipoles belong to each row. Each row is connected to a rectifying circuit which consists of low pass filters and a rectifier. The rectifier is a Ga As Schottky barrier diode that is impedance matched to the dipoles by a low pass filter. The 6 rectifying diodes are

connected to light bulbs for indicating that the power is received. The light bulbs also dissipated the received power.

This rectenna has a 25% collection and conversion efficiency, but rectennas have been tested with greater than 90% efficiency at 2.45 GHz[4].

 The transmission of power without wires is not a theory or a mere possibility, it is now a reality. The electrical energy can be economically transmitted without wires to any terrestrial distance, many researchers have established in numerous observations, experiments and measurements, qualitative and quantitative [5-9]. These have demonstrated that it is practicable to distribute power from a central plant in unlimited amounts, with a loss not exceeding a small fraction of one per cent, in the transmission, even to the greatest distance, twelve thousand miles - to the opposite end of the globe. This seemingly impossible feat can now be readily performed by electrical researchers familiar with the design and construction of my "high-potential magnifying transmitter," There were three popular theories present in the Literature of the late 1800's and early 1900's.

They were:

 1. Transmission through or along the Earth,

 2. Propagation as a result of terrestrial resonances,

 3. Coupling to the ionosphere using propagation through Electrified gases.



Fig.4. Diagram showing the transmitting & receiving circuit For the transmission & reception of electric power by wireless [5].



Fig.5. Two optical forms of wireless antennae formed of search.

 It has been proven that electrical energy can be propagated around the world between the surface of the Earth and the ionosphere at extreme low frequencies in what is known as the Schumann Cavity. Knowing that a resonant cavity can be excited and that power can be delivered to that cavity similar to the methods used in microwave ovens for home use, it should be possible to resonate and deliver power via the Schumann Cavity to any point on Earth. This will result in practical wireless transmission of electrical power. The intent of the experiments and the laboratory Tesla had constructed was to prove that wireless transmission of electrical power was possible. Although Tesla was not able to commercially market a system to transmit power around the globe, modern scientific theory and mathematical calculations support his contention that the wireless propagation of electrical power is possible and a feasible alternative to the extensive and costly grid of electrical transmission lines used today for electrical power distribution. Power transmission system using directional ultrasound for power transmission includes a transmitting device and a receiving device. The transmitting device has a set of ultrasound transducers forming an ultrasound transducer array, wherein the array is a set of spaced individual transducers placed in the X-Y plane disposed to generate an ultrasound beam in the Z direction (Fig.6)

 Another possibility is to use highly efficient fibre lasers

for wireless power transmission where the possibilities are similar to microwaves concept but lasers emit energy at frequencies much higher that microwaves.

 For several years NASA, ENTECH, and UAH have been working on various aspects of collection of the laser radiation and conversion to electrical power for laser wireless power transmission [7].

  



 compatible receiving



 device

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Fig.6. System and method for wireless electrical power Transmission (directional ultrasound for power Transmission) [6].

 A series of innovations that may solve the many macro-problems of transportation energy in space, and the transportation and storage energy within Earth’s biosphere. Below are some of them.

1) Transfer of electrical energy in outer space using the conductive cord from plasma.

2) Method of construction for space electric lines and electric devices.

3) Method of utilization of the plasma cable electric energy.

4) A new very perspective gigantic plasma MagSail for use in outer space as well as a new method for Connection the plasma MagSail to spaceship.

5) a new method of projecting a big electric energy through the Earth's ionosphere.

6) a new method for storage of a big electric energy used Earth as a gigantic spherical condenser.

7) a new propulsion system used longitudinal (cable axis) force of electric currency.

**1. Transferring electric energy in Space**.

 The electric source (generator, station) is connected to a space apparatus, space station or other planet by two artificial rare plasma cables (Fig.1a). These cables can be created by plasma beam [7] sent from the space station or other apparatus.

 

 

**Fig.6.** Long distance plasma transfer electric energy in outer space. *a* - Parallel plasma transfer, *b* – Triangle plasma transfer, *c* - circle plasma transfer. Notations: 1 - current source (generator), 2 - plasma wire (cable), 3 - spaceship, orbital station or other energy addresses, 4 - plasma reflector, 5 - central body.

 The plasma beam may be also made the space apparatus from an ultra-cold plasma [7] when apparatus starting from the source or a special rocket. The plasma cable is self-supported in cable form by magnetic field created by electric currency in plasma cable because the magnetic field produces a magnetic pressure opposed to a gas dynamic plasma pressure (teta-pinch)(Fig. 2). The plasma has a good conductivity (equal silver and more) and the plasma cable can have a very big cross-section area (up thousands of square meter). The plasma conductivity does not depend on its density. That way the plasma cable has a no large resistance although the length of plasma cable is hundreds millions of kilometers. The needed minimum electric currency from parameters of a plasma cable researched in

theoretical section of this article.



**Fig.7.** A plasma cable supported by self-magnetic field. Notations: 1 -plasma cable, 2 - compressing magnetic field,

 3 - electric source, 4 - electric receiver, 5 - electric currency, 6 - back plasma line.

 The parallel cables having opposed currency repels one from other (Fig.1a). They also can be separated by a special plasma reflector as it shown in figs. 1b, 2c. The electric cable of the plasma transfer can be made circular .The radial compressed magnetic force from a circle currency may be balanced a small rotation of the plasma cable (see theoretical section). The circle form is comfortable for building the big plasma cable lines for spaceship not having equipment for building own electric lines or before a space launch. We uild small circle and gradually increase the diameter up to requisite value (or up spaceship). The spaceship connects to line in suitable point. Change the diameter and direction of plasma circle we support the energy of space apparatus. At any time the spaceship can disconnect from line and circle line can exist without user. The electric tension (voltage) in a plasma cable is made two nets in issue electric station (electric generator) [7]-[8]. The author offers two methods for extraction of energy from the electric cable (Fig.3) by customer (energy addresses). The plasma cable currency has two flows: electrons (negative) flow and opposed ions (positive) flow in one cable. These flows create an electric current. (It may be instances when ion flow is stopped and current is transferred only the electron flow as in a solid metal or by the ions flow as in a liquid electrolyte. It may be the case when electron-ion flow is moved in same direction but electrons and ions have different speeds). In the first method the two nets create the opposed electrostatic field in plasma cable (resistance in the electric cable [7]-[8]) (figs.1, 3b). This apparatus resistance utilizes the electric energy for the spaceship or space station. In the second method the charged particles are collected a set of thin films (Fig. 3a) and emit (after utilization in apparatus) back into continued plasma cable

**2. Transmitting of the electric energy to satellite, Earth's Space Station, or Moon.**

The suggested method can be applied for transferring of electric energy to space satellites and the Moon. For transmitting energy from Earth we need a space tower of height up 100 km, because the Earth's atmosphere will wash out the plasma cable or we must spend a lot of energy for plasma support. It is possible this problem may be solved with an air balloon located at 30-45 km altitude and connected by conventional wire with Earth's electric generator. Further computation can make clear this possibility.

 If transferring valid for one occasion only, that can be made as the straight plasma cable 4 For multi-applications the elliptic closed-loop plasma cable 6 is better. For permanent transmission the

Earth must have a minimum two space towers (Fig.4). Many solar panels can be located on Moon and Moon can transfer energy to Earth.

 

 

**Fig.8.** Transferring electric energy from Earth to satellite, Earth's International Space Station or to Moon (or

back) by plasma cable. Notations: 1 - Earth, 2 - Earth's tower 100 km or more, 3 - satellite or Moon, 4 -

plasma cable, 5 - Moon orbit, 6 - plasma cable to Moon, 7 - Moon.

**3. Wireless transferring of electric energy in Earth**.

 It is interesting the idea of energy transfer from

one Earth continent to another continent without ires. As it is known the resistance of infinity (very large) conducting medium does not depend from distance. That is widely using in communication. The

Sender and receiver are connected by only one wire, the other wire is Earth. The author offers to use the Earth's ionosphere as the second plasma cable. It is known the Earth has the first ionosphere layer *E* at altitude about 100 km (Fig. 7). The concentration of electrons in this layer reaches 5104 1/cm3 in daytime and 3.1103 1/cm3 at night (Fig. 7). This layer can be used as a conducting medium for transfer electric energy and communication in any point of the Earth. We need minimum two space 100 km. towers (Fig. 8).

Theory and computation of these ideas are presented in Macro projects section.



**Fig.7**. Concentration/cm3 of electrons (= ions) in Earth's atmosphere in the day and night time in the D, E, F1, and F2 layers of ionosphere.

**Wireless Power Transmission:**

 The microwave transmitting devices are classified as Microwave Vacuum Tubes (magnetron, klystron, Travelling **Components of WPT System**

 The Primary components of Wireless Power Transmission are Microwave Generator, Transmitting antenna and Receiving antenna (Rectenna).

**Microwave Generator**

 The microwave transmitting devices are classified as Microwave Vacuum Tubes (magnetron, klystron, Travelling Wave Tube (TWT), and Microwave Power Module (MPM)) and Semiconductor Microwave transmitters (GaAs MESFET, GaN pHEMT, SiC MESFET, AlGaN/GaN HFET, and InGaAS). Magnetron is widely used for experimentation of WPT. The microwave transmission often uses 2.45GHz or 5.8GHz of ISM band. The other choices of frequencies are 8.5 GHz [13], 10 GHz [14] and 35 GHz [15]. The highest efficiency over 90% is achieved at 2.45 GHz among all the frequencies .

**Transmitting Antenna**

 The slotted wave guide antenna, microstrip patch antenna, and parabolic dish antenna are the most popular type of transmitting antenna. The slotted waveguide antenna is ideal for power transmission because of its high aperture efficiency (> 95%) and high power handling capability.

**Rectenna**

 The concept, the name ‘rectenna’ and the rectenna was conceived by W.C. Brown of Raytheon Company in the early of 1960s [16]. The rectenna is a passive element consists of antenna, rectifying circuit with a low pass filter between the antenna and rectifying

diode. The antenna used in rectenna may be dipole, Yagida,

microstrip or parabolic dish antenna. The patch dipole antenna achieved the highest efficiency among the all. The performance of various printed rectenna is shown in Table I. Schottky barrier diodes (GaAs-W, Si, and GaAs) are usually used in the rectifying circuit due to the faster reverse recovery time and much lower forward voltage drop and good RF characteristics. The rectenna efficiency for various diodes at different frequency is shown in table.



## Fig: Functional Block Diagram of Wireless Power Transmission System

|  |  |  |
| --- | --- | --- |
| Type ofRectenna | OperatingFrequency(GHz) | Measured PeakConversionEfficiency (%) |
| Printed Dipole  | 2.45 | 85 |
| Circular Patch | 2.45 | 81 |
| Printed dualrhombic  | 5.6 | 78 |
| Square patch  | 8.51 | 66 |

Table 1. Performance of Printed Rectenna

|  |  |  |  |
| --- | --- | --- | --- |
| Frequency(GHz) | SchottkyDiode | MeasuredEfficiency(%) | CalculatedEfficiency(%) |
| 2.45  | GaAs-W | 92.5 | 90.5 |
| 5.8  | Si | 82 | 78.3 |
| 8.51 | GaAs | 62.5 | 66.2 |

Table 2. Rectenna Efficiency for Various Diodes at

Different Frequency

III. MERITS, DEMERITS & ECONOMICS OF

WIRELESS TECHNOLOGIES

***3.1. Merits***

 An electrical distribution system, based on this method would eliminate the need for an inefficient, costly, and capital intensive grid of cables, towers, and substations. The system would reduce the cost of electrical energy used by the consumer and rid the landscape of wires, cables, and transmission towers.

 There are areas of the world where the need for electrical power exists, yet there is no method for delivering power. Africa is in need of power to run pumps to tap into the vast resources of water under the Sahara Desert. Rural areas, such as those in China, require the electrical power necessary to bring them into the 20th century and to equal standing with western nations.

 The wireless transmission will solve many of these problems The electrical energy can be economically transmitted without wires to any terrestrial distance, so there will be no transmission and distribution loss. More efficient energy distribution systems and sources are needed by both developed and under developed nations. In regards to the new systems, the market for wireless power transmission is enormous. It has the potential to become a multi-billion dollar per year market.

 The increasing demand for electrical energy in industrial

nations is well documented. If we include the demand of third world nations, pushed by their increasing rate of rowth, we could expect an even Faster rise in the demand for electrical power in the near

future. These systems can only meet these requirements with

90–94 % efficient transmission [3, 8].

***High Transmission Integrity and Low Loss*:-**

 To transmit wireless power to any distance without limit. It makes no difference what the distance is. The efficiency of the transmission can be as high as 96 or 97 per cent, and there are practically no losses.

***3.2. Demerits***

***Biological Impact****:-*

One common criticism of the Tesla wireless power system is regarding its possible biological effects. Calculating the circulating reactive power, it was found that the frequency is very small and such a frequency is very biologically compatible.

***Economic Impact:-***

 The concept looks to be costly initially. The investment cost of Tesla Tower was $150,000 (1905). In terms of economic theory, many countries will benefit from this service. Only private, dispersed receiving stations will be needed. Just like television and radio, a single resonant energy receiver is required, which may eventually be built into appliances, so no power cord will be necessary! Monthly electric utility bills from old-fashioned, fossil-fuelled, loss prone electrified wire-grid delivery services will be optional, much like “cable TV” of today. In the 21st century, “Direct TV” is the rage, which is an exact parallel of Tesla’s “Direct Electricity.”

**IV. CONCLUSION**

 The transmission of power without wires is not a theory or a mere possibility, it is now a reality. The electrical energy can be economically transmitted without wires to any Terrestrial distance. Many researchers have established in numerous observations, experiments and measurements, qualitative and quantitative.

 Dr.N.Tesla is the pioneer of this Invention.

 Wireless transmissions of electricity have tremendous

Merits like high transmission integrity and Low Loss (90 – 97% efficient) and can be transmitted to anywhere in the globe and eliminate the need for an inefficient, costly, and capital intensive grid of cables, towers, and substations. The system would reduce the cost of electrical energy used by the consumer and get rid of the landscape of wires, cables, and

transmission towers. It has negligible demerits like reactive power which was found insignificant and biologically compatible.

 It has a tremendous economi*c* impact to human society. Many countries will benefit from this service. Monthly electric utility bills from old-fashioned, fossil-fuelled, lossprone electrified wire-grid delivery services will be optional, much like “cable TV” of today.

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