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Wireless Power Transmission via Solar power Satellite

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ABSTRACT

In this paper we will discuss the concept of solar power satellite, microwave power transmission technology and necessary of SPS. The solar power satellite (SPS) is a energy system. The solar cells collect the sunlight and convert sunlight to electricity, and transfer from the geostationary orbit to ground. The frequency ratio of Energy will be changed and then beamed to a receiver site on earth are reconverted to electricity by using transmitting and receiving antenna using the technology of wireless power transmission that is transmitting the electricity as a microwave so the reduce the transmission and distribution losses. This topic are also known as the microwave power transmission.

This paper are also provide an analysis of wireless power transfer with a assessment of it's practical applicability in terms of power range and efficiency. The various technologies are available for wireless power transmission of electricity and the need for a wireless energy transmission will be discussed also it's advantages, disadvantage, biological impacts and applications are presented.

KEYWORDS

Wireless power transmission, Microwave power transmission, Solar power satellite, Rectenna.

1. INTRODUCTION

A major problem facing Planet Earth is provision of an adequate supply of cleanenergy. we are facing three tremendous challenges which are, population growth, resource consumption, and environmental degradation ,all these things converging particularly in the matter of sustainable energy supply." It is widely agreed that our current energy practices will not provide for all the world's peoples in an sufficient way and still leave our Earth with a livable environment. Hence, a one of the most important task for the new century will be to develop sustainable and environmentally friendly sources of energy. The plan of future energy needs over this new century show an increase by a factor of at least two and one Half, perhaps by as much as a factor of five. Indeed, the plan indicates that the amount of energy derived from new renewables by 2050 will exceed that presently provided by oil and gas combined. This would causes a major change in the world's energy infrastructure. It will be a difficult task to us to acquire this planned amount of energy.We know that 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 generator to the consumer. The resistance of the wire used which is used in the electrical grid distribution system causes a loss of 26% -30% of the energy generated. This losses implies that our present system of electrical distribution is only 70% -74% efficient.

Todays global scenario has totally changed and a lot of a tremendous development occurred in every field. If we don't concentrate towards development of New power technology we have to face a disaster in the development of power sector. The transmission of power without wires could be one another noble alternative for electricity transmission.

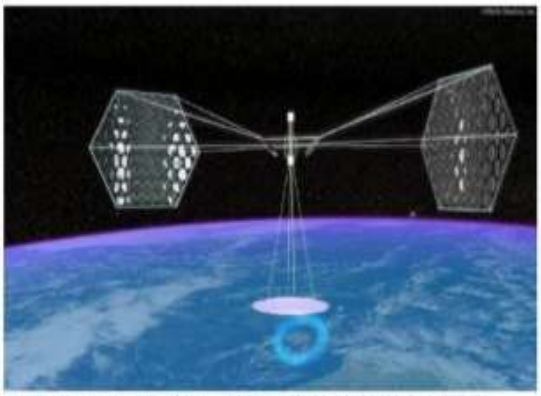


Figure 1 shows a design of Solar Power Satellite (SPS)

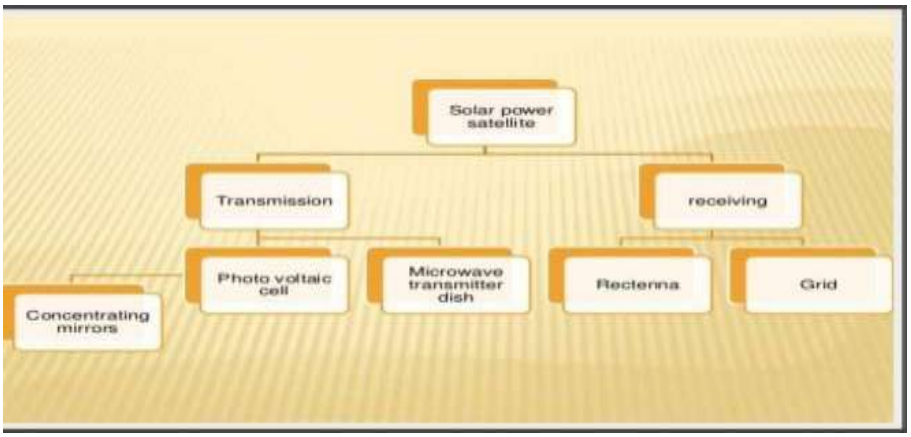
WPT is one of the oldest power transmission technologies, WPT seeing a resurgence of interest. Scientist and engineer have no over the past century that transferring electric power does not require wire to be in physical contact. Wires typically. allowed device to receive both power and communicated with other device. Wireless data transmission eliminates the need for wire to carry the data. This are also known as wireless power transmission technology.

But, we know that "Energy and environment" is one of the most important global issues. And the 80% of energy comes from fossil fuels. If we continue to use the fossil fuels resources so they will completely lost within 100-150 years. the global problem in the close a earth system will be effectively solve by a paradigm shift to the open earth space system. There is unlimited constant solar energy supply in space free from the weather conditions, quite different from that on the earth. This concept of the SPS is to tap the solar energy using a large scale photovoltaic array in space and to transmit it to the ground using microwave or laser beam. It has a great potential for a large scale energy system.

2. SOLAR POWER SATELLIT

Basic idea of SPS is to collect the solar energy in orbit and send it to ground by microwave, laser beam or some other ways. The concept of the Solar Power Satellite energy system is to place giant satellites, covered with vast arrays of solar cells, in geosynchronous orbit 22,300 miles above the Earth's equator. Each satellite will be illuminated by sunlight 24 hours a day for most of the year. Because of the 23" tilt of the Earth‟s axis, the satellites pass either above or below the Earth‟s shadow. It is only during the equinox period in the spring and fall that they will pass through the shadow. They will be shadowed for less than 1% of the time during the year. The solar cells will convert sunlight to electricity, which will then be changed to radio-frequency energy by a transmitting antenna on the satellite and beamed to a receiver site on Earth. It will be reconverted to electricity by the receiving antenna, and the power would then be routed into our normal electric distribution network for use here on the Earth. Figure 1 illustrates the concept. The great advantage of placing the solar cells in space instead of on the ground is that the energy is available 24 hours a day, and the total solar energy available to the satellite is between four and five times more than is available anywhere on Earth and 15 times more than the average location. Testing has demonstrated that wireless energy transmission transmission to the Earth can be accomplished at very high efficiencies. Tests have also shown that the energy density in the radio-frequency beam can be limited to safe levels for all life forms. The concept is simple;

thetechnology exists [4] The SPS is a gigantic satellite design as an electric power plant orbiting in the geostationary earth orbit. Which used wireless power transmission of space based solar power. At means of receiving power on earth, for example via microwave antennas.
It consists of mainly three important parts/segments; solar energy collected 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. The first solar collector can be either photoelectric cell and Solar thermal turbine. The second DC to microwave converter of the SPS it may be either microwave tube system. And third segment is an antenna array

The SPS system will requires a wast receiving area with a rectenna array and the power network connected to the existing power Grid on the ground. Although each rectenna element supply only a few watts. The total receiving power is in the gigawatts (GB).

A rectenna may be used to convert the microwave energy into electricity conversion efficiencies exceeding 95% have been realized. The earth base receiver rectenna is a critical path of the SPS concept. It should consists of many short dipole antenna, connected via diodes. Microwave broadcast from the SPS will be received in the dipole with about 85% efficiency. This rectenna has 25% collection and conversion efficiency, but rectenna have been tested with greater than 90%.

3. WIRELESS POWER TRANSMISSION

In 1893, Nikola Tesla demonstrated the illumination of vacuum bulbs without using wires for power transmission at the World Columbian Exposition in Chicago. William C. Brown, the pioneer in wireless power A Review of Wireless Power Transmission Via Solar Power Satellite transmission technology, had designed, developed a unit and demonstrated to show how power can be transferred through free space by microwaves. In 1961, Brown published the first paper proposing microwave energy for power transmission, and in 1964 he demonstrated a microwave-powered model helicopter that received all the power needed for flight from a microwave beam at 2.45 GHz from the range of 2.4GHz – 2.5 GHz frequency band which is reserved for Industrial, Scientific, and Medical (ISM) applications. Typical WPT is a point-to-point power transmission. For the WPT, we had better concentrate power to receiver. It was proved that the power transmission efficiency can approach close to 100%[5] The main components of Wireless Power Transmission are Microwave Generator, Transmitting antenna and Receiving antenna (Rectenna). These essential components are further described in detail (Figure 1) 1) Microwave Generator: The Microwave generator takes the DC power generated by the solar cells and converts it to radiated RF output. It consists of a DC-RF conversion oscillator, which is typically low-power and followed by a gain stage and finally a power amplifier (PA).Typically the microwave generating devices are classified as microwave tubes (e.g klystron, magnetron, TWT etc) or semiconductor MW devices. 2) 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[3]. We need higher efficient generator/amplifier for the MPT system than that for the wireless communication system. For highly efficient beam collection on rectenna array, we need higher stabilized and accurate phase and amplitude of microwave when we use phased array system for the MPT. 3) Rectenna: The concept and the name „rectenna" was conceived by W.C. Brown of Raytheon Company in the early of 1960s . A Rectenna is a Rectifying antenna, a special type of antenna that is used to directly convert microwave energy into DC electricity. Its Its elements are usually arranged in a multi element phased array with a mesh pattern reflector element to make it directional. Rectennas are being developed as the receiving antennas in proposed microwave power transmission schemes, which transmit electric power to distant locations using microwaves. Rectennas are used in RFID tags; the energy to power the computer chip in the tag is received from the querying radio signal by a small rectenna. One possible future application is a receiving antenna for solar Power satellites. A simple rectenna element consists of a dipole antenna with a Schottky diode placed across the dipole elements. The diode rectifies the AC current induced in the antenna by the microwaves, to produce DC power. Schottky diodes are used because they have the lowest voltage drop and highest speed and therefore waste the least amount of power due to conduction and switching. Large rectennas consist of an array of many such dipole elements Rectennas are highly efficient at converting microwave energy to electricity. In laboratory environments, efficiencies of over 85% have been observed

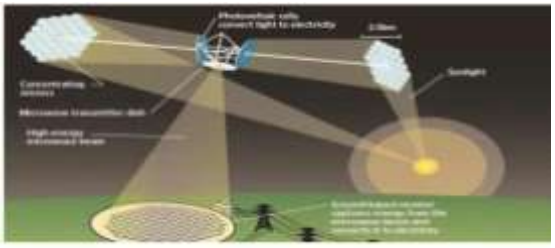
4. MICROWAVE POWER TRANSMISSION

Microwave of 450KW at 2.388 GHz was transmitted and 30 KW was obtained at the retina. This demonstrated the feasibility of Microwave power transmission very clearly.

Microwave frequency for SPS has been selected in the range of 1-10 GHz compromising between antenna size and atmospheric attenuation. If we choose a frequency in the industrial, scientific and medical radio bands, 2.45 or 5.8GHz is the potential candidate.

5. WORKING

Solar power generates the satellites which are launched into space and transmitting power to Earth stations.



Mainly, The SPS satellites would be put in the high earth orbit at geosynchronous location. A large rectenna array facility will be provided to the Earth to collect the incoming microwaves.

Since most of the research is done in the 2.4 GHz to 5.8 GHz range, there is some spectrum regulatory issues to deal with. Also from where the retro directive antenna system is unproven, there is the health concern that the microwave beam could veer off target and microwave some unsuspecting family. However, a Japanese Government is planning to send up 10 to 100 kW low earth orbit satellite to prove its feasibility.

ADVANTAGES

- Remove physical infrastructure " Grids and Towers"
- Low cost because remove the cost of towers and cable.

- Microwave are more environments friendly it does not involve emission of Corbin gasses
- Zero fuel cost
- Electricity bills using conventional supply can be very low.

DISADVANTAGES

- Maintenance of SPS is expensive and challenging.
- The size of construction for the retina is massive.
- Transportation of all the materials from earth to space and installation is highly tough.
- The other disadvantages of the concept is interference of microwave with present communication system.

APPLICATION

- The one another major applications of WPT are Wireless power source or Ubiquitous Power Source, RF Power Adaptive Rectifying Circuits and Wireless
- We can design a wireless-power-transfer system for simple electronic devices like mobile charges, mobile phones which not only reduces the risk of shock, but also the efforts to plug repeatedly into the sockets.

6. BIOLOGICAL IMPACTS

Common belief fear the effect of microwave radiation. but the studies in this domain repeatedly prove that the microwave radiation level would be never higher than the does received. Means it is slightly higher than the emission created by telephone cellular telephone operate with power densities at or below the ANSI/IEEE exposure standards. Thus public exposure to WPT field would also be below existing safety guidelines.

7. CONCLUSION

one of the most critical technologies for the SPS is microwave power transmission for the geosynchronous orbit to the ground. This concept offers a large possibilities for transmitting power with negligible losses. It just appears almost certain that there will be a shift towards renewable sources and that solar will be a major contributor. Although the required technologies are quite challenging, continuum research activities along with the proposed road map will lead the opening the new SPS ear in 2030's

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