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A REVIEW ON SOLAR POWER SATELITE

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ABSTRACT: Since solar energy is abundant in space, the primary use of satellites is to capture the sun's energy and send it back to Earth. Solar Power Satellites (SPSs) can face the sun more than 99 percent of the time, so there's no need for expensive storage devices when the sun isn't shining. The satellite would only be in shadow for a few days each spring and fall at equinoxes. The unburned heat is then sent back into space. The power can be sent to where it's needed, so you don't need to invest as much as you would in a grid. In 1968, Dr Peter Glaser pioneered the idea of a large-scale solar power satellite (SPS), which consists of a large number of solar collectors, each with a square mile of square footage, to collect and convert solar energy into a powerful electromagnetic microwave beam. The beam is then sent back to earth via large receiving antennas, where it is fed into the nation's electrical power grid.

1) INTRODUCTION:

The Solar Thermal Power Reference System (SPS) was first proposed by the Department of Energy (DOE) and NASA in 1979. The main goal of the SPS was to create a large-scale power infrastructure in the universe, with approximately 60 SPS providing a total of 300GW. However, due to the high cost of the system, the lack of an evolutionary concept, and the 1980-81 energy crisis, all US efforts in the SPS were discontinued with the intention of re-evaluating the system after approximately 10 years. During this period, there was international interest in the SPS, which led to the WPT experiment conducted in Japan.

2) SOLAR POWER SATELLITE SYSTEM:

Space-based solar power essentially consists of following functional units:

A. A Solar energy collector to convert the solar energy into DC (Direct current) electricity.

B. A DC to Microwave converter.

C. Large antenna array to beam the Microwave power to the ground.

D. A means of receiving power on earth, for example via microwave antennas (Rectenna).

2.1 Solar Energy Conversion - Solar Photons to DC

Fig : shows a design of Solar Power Satellite (SPS)

Two main methods have been studied to convert sunlight into electricity: photovoltaic (PV) conversion and solar dynamic (SD) conversion. Most analyzes of solar powered satellites have focused on solar energy conversion (commonly known as "solar cells"). Photovoltaic conversion uses semiconductor cells (such as silicon or gallium arsenide) to convert photons directly into electrical energy using quantum mechanical mechanisms.

Photovoltaic cells are not perfect in practice, as the purity of the material and processing issues during manufacturing affect performance. Some new thin film methods are less efficient but much cheaper and generally lighter. In the SPS implementation, the solar cells will likely be quite different from the glass-shield solar panels that many are familiar with on Earth today, as they are weight-optimized and designed to withstand space radiation (thin-film silicon solar panels happen to be very sensitive to ionizing radiation), but do not need to be encapsulated with anti-corrosive elements. They do not require the structural support required for ground-based applications, where significant gravity and wind loads impose structural requirements on ground-based applications.

2.2 Converting DC to Microwave Power

Microwave oscillators such as Klystrons, Magnetrons can be used to convert DC power into microwaves for transmission through an antenna to the earth receiving antenna. Direct current must be converted to microwave power at the transmitting end of the system using a microwave magnetron. The microwave oven has a high voltage system. The core of the high voltage system is a magnetron tube. A magneton is a diode-type electron tube that uses the interaction of magnetic and electric fields in a complex cavity to produce very high peak power oscillations. It uses a radial electric field, an axial field, an anode structure and a cylindrical cathode. A cylindrical cathode is surrounded by a hollow anode and thus a radial electric field is created. The magnetic field of the permanent magnet added above and below the two tube structures is axial. The top magnet is the north pole and the bottom magnet is the south pole. An electron moving through space tends to create a magnetic field around itself. The magnetic field on the right is weakened because the self-induced magnetic field subtracts from the permanent field. Thus, the trajectory of the electron is bent in that direction, resulting in a circular motion that moves to the anode. This process begins by applying a low voltage to the cathode, which causes it to heat up. An increase in temperature causes more electrons to be emitted. That cloud of electrons would be ejected from the negatively charged cathode. The distance and speed of their travel would increase with the intensity of the applied voltage. The speed is obtained from the negative 4000V DC. This is generated by a voltage doubling circuit. Electrons explode from the cathode like a small rocket.

As the electrons move toward their destination, they encounter a powerful magnet. The effect of the permanent magnet tends to bend the electrons away from the anode. Due to the combined effect of the electric and magnetic fields on the trajectory of the electrons, they return to a path almost at right angles to their previous direction, resulting in a widening circular orbit around the cathode, which eventually reaches the anode. The swirling cloud of electrons forms a swirl pattern. The combination of this rotating space charge wheel and the configuration of the anode surface creates a very high frequency alternating current in the resonance cavities of the anode. The output is taken from one of these cavities through a waveguide. A cheap and readily available magnetron is used in the country. The same principle would be used, but a special magnetron would be developed for space use. Because of the pulsed operation of these magnetrons, they generate a lot of spurious noise. A solar powered satellite operating with a radiation power of 10 GW would transmit a total of one microwatt with a channel width of 400 Hz.

2.3 Transmitting Antennae

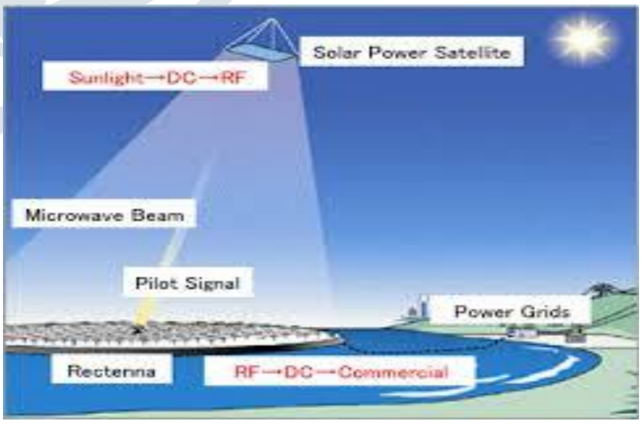
Power transmission by radio waves can be made more directional, allowing longer electromagnetic radiation at shorter wavelengths, usually in the microwave range. Energy radiation using microwaves has been proposed for energy transfer from orbiting solar powered satellites to Earth, and energy radiation to a deorbiting spacecraft has also been considered. Components can be sized by transmitter-receiver distance, wavelength, and the Rayleigh criterion or diffraction limit used in standard RF antenna design, which also applies to lasers. In addition to Rayleigh's criterion, the diffraction limit of the Airyand is often used to determine the approximate size of the point at some distance from the aperture. Rayleigh's criterion states that every radio wave microwave or laser beam spreads and attenuates and spreads in distance; the larger the transmitter antenna or laser aperture compared to the radiation wavelength, the denser the beam and the less it spreads as a function of distance (and vice versa). Smaller antennas also suffer from excessive sidelobe losses. But the concept of a laser aperture is very different from an antenna. Typically, a laser aperture much larger than the wavelength induces multiple beams, and collimators are mostly used before coupling the beam to the fiber or spacer. Finally, the width of the beam is physically determined by diffraction, which results from the size of the plate relative to the wavelength of the electromagnetic radiation used to generate the beam. Microwave radiation can be more effective than lasers and is less subject to atmospheric attenuation, as dust or water vapor is lost to atmospheric evaporation to vaporize the water in contact. The power levels are then calculated by combining the above parameters and adding the characteristics corresponding to the gain losses of the antenna d the transparency of the medium passing through the radiation. This process is called link budgeting, but the math above does not take into account atmospheric absorption, which can have a significant damping effect on energy dissipation in addition to heavy fading and loss of Quos.

3) TRANSMISSION:

Since electromagnetic induction and electromagnetic radiation have disadvantages, we move on to the application of electrical conductivity and resonant frequency methods. Of these, the resonant induction method is the most feasible for reasons given later. In the distant future, this method may allow the removal of many existing high-voltage power lines and facilitate the interconnection of power generation facilities around the world. A microwave source consists of a microwave magnetron with electronics that control the output power. Microwave oven power ranges from 50 watts to 200 watts at 2.45 GHz. A coaxial cable connects the output of the microwave source to the coaxial wave adapter. This adapter is connected to the tuning waveguide ferrite circuit and the tuning waveguide section to match the waveguide impedance to the antenna input impedance. A grooved waveguide antenna consists of 8 waveguide sections, each section having 8 grooves. These 64 card slots radiate power evenly across the open space in a straight line. The slotted waveguide antenna is perfect for power transmission due to its high aperture efficiency (>95%) and high power handling capability. Microwaves lie in the electromagnetic spectrum with frequencies ranging from 0.3 to 300 GHz. The energy emitted by microwaves is very scattered by nature, so the area of the receiving antenna must be very large compared to the transmitter. Although the use of microwaves to transmit energy from space to Earth is attractive, most microwaves affect significant atmospheric disturbances. However, there are certain frequency windows where these interactions are minimized. The frequency windows where atmospheric signal attenuation is minimal are 2.45-5.8 GHz and also 35-38 GHz; in particular, we can expect a loss of 2-6% and 8-11% in these two microwave signal ranges. Since the microwave power is radiated point to point using parabolic antennas (drum antennas), the free space loss (FSPL) is not significantly high. Wireless power transmission (using microwaves) is well proven. Tens of kilowatts were tested in 1975 at Goldstone, California, and more recently (1997) at Grand Bassin, Reunion Island. With these methods, distances in the order of a kilometer are reached.

4) GROUND SEGMENT – RECEPTION:

The SPS system requires a large receiving area with a straight line system and power grid connected to ground power grids. Although each line element produces only a few watts, the total output is in gigawatts (GW).



A rectifier can be used to convert microwave energy back into electricity. The conversion efficiency is more than 95%. The word "Rectenna" is composed of "rectifier circuit" and "antenna". A rectifier antenna, called a rectenna, receives the transmitted power and converts the microwave power into direct current (DC). The rectenna is a passive element with a rectifier diode and is used without an additional power supply. The rectifier antenna has a low-pass filter between the antenna and the rectifier diode to prevent reradiation of higher harmonics. It also has an output smoothing filter. This sample direct antenna consists of 6 rows of dipole antennas, each row containing 8 dipoles. Each line is connected to a rectifier circuit consisting of low-pass filters and a rectifier. The rectifier is a GA-As Schottky blocking diode impedance-matched to the pass filter dipoles. 6 rectifier diodes are connected to the bulbs to indicate that current has been received. Light bulbs also dissipate the received power. The ground receiver antenna (or rectenna) is an essential part of the original SPS concept. It would consist of several short dipole antennas connected by diodes. The microwaves sent by the SPS are received in the dipoles at approximately 85% power. With a traditional microwave antenna, the reception efficiency is still better, but the cost and complexity are also significantly higher, almost certainly prohibitive. The diameter of the rectangle would be several kilometers. Crops and farm animals can be grown under the rectenna, because the thin wires used as supports and dipoles only slightly reduce the sunlight, or uncultivable land can be used, so such a rectenna would not be so expensive in terms of land. used as intended. Its straight line collection and conversion efficiency is 25%, but rectangles have been tested with over 90% efficiency.

5) IMPORTANT POINTS:

The SBSP concept is attractive because space has several important advantages over Earth and the surface for collecting solar energy. There is no air in space, so the collecting surfaces would receive much stronger sunlight that is not affected by the weather. In geofixed orbit, the SPS would be illuminated more than 99% of the time. This SBSP feature avoids the cost of storage (dams, oil tanks, coal stockpiles) required in many land-based power generation systems.

5.1 Advantages of Space Solar Power

1) Unlike oil, gas, ethanol and coal plants, space solar energy does not produce greenhouse gases. 2) Unlike bioethanol or biodiesel, space solar energy does not compete for increasingly valuable farmland and does not depend on natural gas fertilizer. Food may continue to be an important export product rather than a fuel supplier. 3) Unlike nuclear power plants, the space sun does not produce hazardous waste that must be stored and guarded for hundreds of years. 4) Unlike solar and wind power plants on Earth, space solar energy is available 24/7 in massive amounts. It works regardless of cloud cover, daylight or wind speed. 5) Unlike nuclear power plants, space solar is not an easy target for terrorists. 6) Unlike coal and nuclear fuels, space solar energy does not require environmentally problematic mining. 7) Space solar energy will ensure true energy independence for the countries that develop it, eliminating the most important source of national competition for limited terrestrial energy sources.

5.2 Disadvantages of Space Solar Power

1) SPS maintenance is expensive and difficult. 2) Geosynchronous orbit is already widely used; space debris from such a large project could be at risk. 3) The size of the containment structure is

huge. 4) Transportation of all materials from the ground to the room and installation is very difficult.

6) CONCLUSION:

Growing global energy demand is likely to continue for decades. New power plants of all sizes are being built. Fossil fuels will run out in another 3-4 decades. However, energy independence is something that only space-based solar can provide. Space-based solar power (SBSP) is attractive because it is much cheaper than land-based solar power. It has been predicted that by 2030, the world will need 30 TW of electricity generated from renewable energy sources, and solar energy alone can generate about 600 TW. CO2 gas emission levels can be minimized and controlled. In this way, the problem of global warming is largely solved. Based on current research, space-based solar power should no longer be envisioned as an unimaginably large initial investment. In addition, space-based solar energy systems appear to have many significant environmental advantages over alternative approaches to meeting the Earth's growing energy needs, including the need for a significantly smaller land area than ground-based solar energy systems. Although the success of the space sun depends on the successful development of key technologies, it is certain that the result will be worth the effort. Solar energy from space can solve our energy problems in the long run. The sooner we start and the more we work, the shorter the "long time" will be.

7) REFERENCES

[1] J. O. Mcspadden and J. C. Mankins, “Space solar power programs and microwave wireless power transmission technology,” IEEE Microwave Mag., pp. 46–57, Dec. 2002.

[2] W. C. Brown and E. E. Eves, "Beamed microwave power transmission and its application to space," IEEE Transactions on Microwave Theory and Techniques, vol. 40, no. 6, June 1992.

[3] "Space-Based Solar Power". United States Department of Energy *(DOE). 6 March 2014.*

[4] "Space-based solar power". ESA–Advanced Concepts Team. 15 April 2013. Retrieved August 23, 2015.