Wireless power transmission technologies for solar power environmental sciences e...

Environment, Ecology

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Abstract- The chief beginning of the energy in our life comes from fossil fuels, which is a non-renewable resource moreover it produces high sum of CO2. One of the solutions to planetary energy crises is development of geosynchronous orbit solar power orbiters (SPS) . It provides a clean and efficient beginning of energy by roll uping the solar power from infinite and so transporting it to the Earth. This is a new beginning of clean energy. Space solar power can work out our energy and nursery gas emanations jobs. Space solar power can supply big measures of energy to each and every individual on Earth with really small environmental impact. The clip mean power per unit country in infinite is 5-10 times larger than that on the land, while the power loss for the radio power transmission/reception is expected less than 50 % . This paper provides a reappraisal on the presently

formulated engineerings like microwave power transmittal, laser power transmittal and the intercrossed power transmittal systems for transmittal of solar power to the Earth from SPS. It besides talks about the effects on human wellness andenvironmentdue to SPS. Finally the paper suggests the development of a bread board modelA for microwaveA radio power transmittal (WPT) . The intents of utilizing this bread board theoretical account is to obtain a precise directional control of WPTA technologyA , which includes the direct sensing of rectenna sites, and the microwave beam control accomplishment with high angular preciseness, and to clear up the extension features of the microwaveA powerA in the ionosphere.

KEYWORDS - Microwave, Solar power orbiter, wireless power transmittal.

I. Introduction

Energy and environment are one of the most of import planetary issues which have to be resolved to prolong our society. 80 % of energy in our life comes by using fossil fuels. If we continue to utilize the dodo fuel resources at the current ingestion rate, they will be wholly over within 100-150 old ages. Furthermore, the immense sum of ingestion of fossil fuel additions CO2 concentrations in the ambiance, which raises serious environmental issues. If we continue to depend on the dodo fuel, we will see significant debasement of life quality within this century. The emanation of green house gases besides leads to a figure of wellness jobs. Another beginning of energy is from atomic power, but the job of this beginning is the waste disposal factors. The energy ingestion graph is shown in fig 1 [6] . The planetary issues in the closed Earth system will be efficaciously solved by a paradigm

displacement to the unfastened earth- infinite system. The life clip of Sun is estimated as 4-5 billion old ages. There is limitless changeless solar energy supply in infinite free from conditions conditions, rather different from that on the Earth, therefore we can see solar power orbiter as a long term beginning of energy.

The construct of the SPS is to tap the solar energy utilizing a large-scale photovoltaic array in infinite and to convey it to the land utilizing optical maser beam or micro-cook as shown in fig. 2 [6] . It has a great potency for a large-scale energy system to replace the dodo fuel workss. The clip mean power per unit country in infinite is 5-10 times larger than that on the land, while the power loss for the radio power transmittal and response is expected to be less than 50 % . Hence SPS has a competitory advantage over the solar power workss on the land.

Solar power orbiter has the capacity to supply about all the electrical demands of our planet. Furthermore it is green beginning of energy, it does non breathe any unsafe green house gases, and it will non bring forth any risky wastes excessively, it will supply power 24 hours a twenty-four hours 7 yearss a hebdomad in immense measures and it works irrespective of cloud screen, daylight or weave velocity. But it requires heavy developmental cost.

The SPS was foremost brought up by Peter Glaser in 1968, followed by NASA/DOE surveies in the 1970 's. Since the early probes, different types of the SPS have been proposed, more than 30 in the universe. Most of the SPS theoretical accounts proposed so far uses microwave instead than optical

maser for the radio power transmittal, because the power, efficiency both at the sender and receiving system is by and large higher and fading through the ambiance is lower for microwave as seen with that of optical maser.

II. MICROWAVE POWER TRASMISSION FOR SPS

Microwave frequence for SPS has been selected in a scope of 1-10 GHz, compromising between atmospheric fading and antenna size. Fig. 3 [5] illustrates the constellation of infinite solar power systems dwelling of SPS and associated land sections. If we choose a frequence in the industrial, scientific and medical (ISM) wireless sets, 2. 45 or 5. 8 GHz are the possible campaigner. 2. 45 GHz was selected in the early stage survey, but 5. 8 GHz has been late chosen as a more desirable frequence due to recent accelerated advancement in C-band RF engineering. The microwave power transmittal system has the undermentioned map, i. e.

1) First the transition of direct power from photovoltaic cell to micro-cook power.

2) Followed by the formation and control of microwave beam aimed to fixed location in

Earth.

3) Last roll uping the microwave energy and change overing it into electrical energy on the

Earth surface.

Therefore the microwave WPT system consists of a sender (in infinite) , beam control mechanism and having aerial system (on the Earth) . As for the microwave generator, tubings such as magnetron, klystron, and TWT have been proposed for the SPS usage because the power transition efficiency is well high more than 70 % at low cost.

Semiconductor amplifier is another possible campaigner as the power efficiency has been moderately improved to 60-70 % with low cost outlook. Besides the power efficiency, beam indicating engineerings to convey the microwave power beam exactly to the receiving locations are indispensable for the power transmittal. They are curious to the radio power transmittal, non covered by the bing communicating engineerings. A beam angle 100 I? rad with a 10 I? rad indicating truth is required for the 5. 8 GHz transmittal from an aerial of 2 kilometers square in the geosynchronous orbit to a response site of 3. 5 kilometers diameter on the land. The conveying aerial will be assembled by a figure of array aerial panels which consist of sub-array aerials. Wholly more than 1 billion aerials will be installed as in Fig. 4 [6] .

A retro-directive engineering with a pilot signal from the land will be used to command the microwave beam from each aerial panel directing to the land station. Although each panel is sufficiently stiff for microwave beaming, comparative gesture between the panels can non be avoided for the big aerial assembly. In order to organize a microwave beam exactly focused at the land station, the stage of microwave from each panel needs to be adjusted between the panels, which requires radical new engineerings. In the

absence of the pilot signal, sender will automatically diphase its power beam and the peak power denseness lessenings by the ratio of the transmission elements. Still small spot of energy is lost due to side lobes which are caused by diffraction. To avoid this loss we have to do having aerial of really big size to suit the side lobes, which is practically non possible.

The microwave power at the having site is rectified to supply dc power utilizing arrays of rectifying aerial (rectenna) as shown in Fig. 5 [6] with Schottky rectifying tube. The power transition efficiency for individual rectenna exceeds 80 % in a power scope more than 50 mW. However, farther research is required to better the power efficiency for 1 mW category input and rectenna array as a whole. We use Schottky rectifying tube since it has lowest electromotive force bead and highest velocity of operation, hence waste least sum of power due to conductivity and shift. Presentation of microwave power transmittal towards SPS on land and on a little orbiter or on the International Space Station.

III. LASER WIRELESS POWER TRANSMISSION

Satellite and system architectures based on optical maser radio power transmittal were foremost considered earnestly during the SPS Exploratory Research andTechnology(SERT) plan [6] . Laser systems have one major advantage for power transmittal which is the aperture aggregation efficiency. Whereas microwave power transmission and receiving aerials are sized in kilometres, laser systems can be sized in metres. A secondary advantage is that optical maser based systems lend themselves more readily to incremental developments than microwave based systems. However, the

major hurdle that optical masers based systems face is atmospheric losingss particularly due to the rain fading. To supply uninterrupted power, which would be necessary to measure up SPS as base burden power coevals, the optical maser system would either hold to hold monolithic land energy storage capableness or multiple sites located sufficiently far apart such that one of the sites would be available at all times.

With the lower delivered power per site design standards of the current surveies compared to the DOE/NASA mention system, beam safety has minimum influence on the design of a microwave based solar power orbiter system, nevertheless, it has been a major factor for optical maser based systems. To cover with optical maser oculus and skin exposure bounds, a system of geostationary bunch of optical maser orbiters are distributed uniformly through a sufficient solid angle of infinite, with the beams from the orbiters spread uniformly over the 600m diameter photovoltaic array having site. With such a system, it is possible to keep safety criterions and still present IR visible radiation (1. 03I? m, 1. 06I? m) with a septuple addition in power denseness over natural sunshine. Practical realisation of such a system is through a HALO orbit in which the orbiters appear to travel in a round orbit about a fixed point in infinite. Individual orbiters would hold multiple solid-state optical masers powered by photovoltaic arrays.

Lasers are dispersed among photovoltaic cells to minimise power direction. Light is beamed straight to the Earth or collected by mirrors or through fiber optics to a cardinal guidance mirror and so beamed to the Earth. A fresh attack to get the better ofing weather break of optical maser based power

beaming is to utilize the beamed power to hive away energy at the having site for ulterior transit. A low-earth-orbit (LEO) orbiter would utilize a concentrator Federal solar. Integrated Symmetric Concentrator with concentrator mirrors, photovoltaic arrays and microwave sender phonograph record (500m in diameter) pumped laser to present 10MW of optical maser energy focused into a armored combat vehicle of saltwater incorporating Ti dioxide as a accelerator to divide the H2O into its constituent H and O. Hydrogen can be used as fuel or it can be reacted with CO2 to do methane [1] .

IV. HYBRID LASER-MICROWAVE WIRELESS POWER TRANSMISSION

Laser and micro-cook wireless power transmittal each have alone advantages, i. e. , optical masers require smaller apertures and microwaves are about immune to rain and other atmospheric conditions. Proposals are made to unite the two options such that each would run in its most advantageous environment. The key to the design proposal is a platform operating in the stratosphere at about 20km tallness. Lasers can be used to beam power from orbiters at geostationary orbit through infinite (no atmospheric fading) to a photovoltaic array on the platform. The power would so be retransmitted with microwaves from the platform to a land rectenna. This would minimise both the size of the orbiter sender and land receiving system for an all-weather transmittal system. Drawbacks to such a system include efficiency losingss due to the conversion/retransmission measure and the likeliness of transcending microwave beam power denseness safety criterions. Fig. 6 [1] depicts the schematic of SPS.

V. ENVIRONMENTAL AND HEALTH CONCERNS

An appraisal of the SERT Program by the US National Research Council [5] has recommended more accent and enlargement of its environmental, wellness, and safety attempts, in order to reexamine the environmental, wellness, and safety jeopardies of the design. It is besides necessary to analyze the biological deductions of SPS-WPT. To guarantee environmental wellness and safety, the SERT Program has limited the `` center-of-beam '' power densenesss to the scope of 100-200W/m2

(10-20 mW/cm2) for both microwave and seeable light transmittal. For WPT, the microwave power denseness is projected to be 1. 0 W/m2 (0. 1 mW/cm2) at the margin of the rectenna.

The ANSI/IEEE criterion [6] for maximal allowable human exposure to micro-cook radiation at 2. 45 GHz is 81. 6 W/m2 (8. 16 mW/cm2) averaged over six min and 16. 3 W/m2 (1. 63 mW/cm2) averaged over 30 min, severally, for controlled and uncontrolled environments. The controlled and uncontrolled state of affairss are distinguished by whether the exposure takes topographic point with or without cognition of the exposed person and is usually interpreted to intend persons who are occupationally exposed to the microwave radiation, as contrasted with the general populace. Clearly, beyond the margin of the rectenna, the possible exposure, for either the CERT or Reference System, would be good below that presently allowable to the general populace. The SPS-WPT system, proposed by Japan 's METI, will be designed to hold a land degree microwave power denseness lower than those emitted by cellular nomadic telephones. Cellular telephones operate

with power densenesss at or below the ANSI/IEEE exposure criterions [7] . Thus, public exposure to the SPS-WPT Fieldss would besides be below bing safety guidelines.

At the centre of the microwave beam, power densenesss would be greater than the allowable degree of exposure for controlled state of affairss. Except for care forces, human exposure would usually non be allowed at this location. In the instance of occupationally required presence, protective steps, such as spectacless, baseball mitts, and garments, might be used to cut down the exposure to a allowable degree. However, above the rectenna, where the power denseness is about 250 W/m2 (25 mW/cm2) , research in support of the Reference System has found that some birds exhibit grounds of sensing of microwave radiation. This suggests that migratory birds, winging above the rectenna, might endure break in their flying waies. Furthermore, at higher ambient temperatures, larger birds seem to see more heat emphasis than smaller 1s, during 30 min of exposure [5] . This extra heat, from micro-cook energy deposited inside their organic structure, will emphasize their thermic regulative capacity.

VI. BREAD BOARD MODEL AND FUTURE SCOPE OF COMMERCIAL SPS

The staff of life board theoretical account is formed by a thin panel construction with a thickness of 6 centimeter, and the panel consists of aA transmittal aerial bed, microwave elaboration bed and thermic radiation bed, severally. Performances of the bread board were measured and evaluated. Additionally, the microwave beam maneuvering experiments by the package

retro-directive method were demonstrated. A Performances of the bread board were measured and evaluated. Thermal transeunt features of the bread board theoretical account were simulated.

A engineering roadmap from research stage to commercial stage is shown in Fig. 7 [5] . Based on the consequences from the small-scale presentation experiments in infinite, together with the consequences from the land experiments, we will do a determination on the engineering option, microwave or laser, for the radio power transmittal. With the selected transmittal medium, we will do a 100 kW-class SPS presentation experiment in orbit before 2020. All basic engineerings required for the commercial SPS will be verified at this phase. This attack is in conformity with the basic program on infinite development by the authorities 's infinite development scheme headquarter in Japan. After completion of these presentations Japan will choose a constellation for the initial mark of the commercial SPS. The expected power cost depending to a great extent on the development of infinite transit and public credence will be the major trade off factors for choice. For the selected constellation, 2 MW and 200 MW category works will be constructed and tested before 2030. This scenario guaranties the start of building of the 1 GW category commercial SPS in 2030 's.

VII. Decision

One of the most critical engineerings for the SPS is microwave power transmittal from the geosynchronous orbit to the land. Evolutionary microwave engineerings are required for high power transition efficiency more than 80 % from/to DC and an highly high-precise beam control with 10

I? rad truth. These engineerings will be partly verified in the land presentation experiment within several old ages and will be to the full verified in the infinite experiments within 10 old ages. Although the needed engineerings are rather ambitious, go oning research activities along with the proposed roadmap will take to opening the new SPS epoch in 2030 's.

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