

Space Solar Power Satellite/Station and the Politics

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Abstract— The IPCC (Intergovernmental Panel on Climate Change) concluded that human activities have caused the global warming. A possibility of space environment use as the most hopeful answer to the social dilemma between the global environment and human activities is discussed. Space Solar Power Satellite/Station (SPS) is introduced to solve energy and environmental problems. Microwave power transmission as a key technology for SPS and its history are reviewed. Then importance of political leadership and frequency regulation to realise the SPS is discussed.

Key words: Space Solar Power Satellite/Station (SPS), Microwave Power Transmission (MPT), global warming, ITU-R.

I. INTRODUCTION

In 2007, the IPCC (Intergovernmental Panel on Climate Change) concluded in the Fourth Assessment Report there is no doubt that human activities have caused the global warming. They estimate surface air warming in the 21st century as follows; 1) Best estimate for a "low scenario" is 1.8 °C with a likely range of 1.1 to 2.9 °C, 2) Best estimate for a "high scenario" is 4.0 °C with a likely range of 2.4 to 6.4 °C, 3) A temperature rise of about 0.2 °C per decade is projected for the next two decades for all scenarios. They conclude that we have to reduce the all long-lived greenhouse gases by 50%. What is real cause of change of the global environment? Human activities or Human being itself? We have to consider the cause and solve the answer of social dilemma between the global environment and human activities. In this paper, we discuss a possibility of space environment use is most hopeful answer of the social dilemma.

II. SPACE SOLAR POWER SATELLITE/STATION (SPS) AND MICROWAVE POWER TRANSMISSION (MPT)

To solve the social dilemma between the global environmental issue and human greed, Space Solar Power Satellite/Station (SPS), which was proposed in 1968 [1], has been studied and developed for the future [2]-[5]. The SPS is one of the most important systems which are significant for future humanosphere. The SPS is a gigantic solar power station orbiting in the Geostationary Earth Orbit (GEO) (Fig. 1), in which generated electric power is transmitted to ground via microwave (microwave power transmission, MPT). The SPS system has advantage in producing electricity with much higher efficiency compared with a photovoltaic system placed on the ground because it works night and day and there will be no rain effect. Very little atmospheric absorption of the microwave has already been proved. However, the SPS will require higher efficiency of lighter weight solar cells,

technologies of higher voltage power distribution in space plasmas, higher efficiency and higher accuracy huge phased array for the MPT, and economical rockets.

In Kyoto University, we have carried out many field experiments of the MPT on the ground and in space (Fig. 2) [6]. Recently, we have proposed some applications of the MPT for the ground application as well. One of the hopeful MPT systems is 'Ubiquitous Power Source'. We proposed [7] a system to charge batteries of mobile phones or note PC via microwave (Fig. 3). However, there has been no commercial MPT system yet in the world because of two reasons. One is a frequency regulation problem. There is no legally approved frequency allocation for the MPT yet. The other is shortage of market for effective and economical MPT applications. However, many people have recently noticed the MPT can be used to provide power to μ W devices like IC, sensor, and RF-ID. This system is one-to-many MPT like wireless communication systems. We believe that such approach of using weak microwave to provide the power to μ W devices is very effective to overcome the present frequency regulation.

III. STRATEGY FOR SPS REALIZATION

The SPS is a gigantic system in a scale which has not yet been realized in space. Although technologies will support the construction of SPS, the gigantic SPS will not be realized without international collaboration, politics, and new legal regulation for the SPS. JAXA (Japan Aerospace Exploration Agency) estimated that the construction and maintenance cost of the SPS will be approximately about 8 billion US dollars with future technologies, like low-cost rockets, high efficient phased array MPT system, and ultra light weight space structure. The estimated cost of \$8 billion is less than those spent for cars, or those spent for fashion in Japan. However, people will not be ready for SPS at present because they are still optimistic believing that the environment surrounding us will not get worse much in the near future. The IPCC Fourth Assessment Report indicated that global environment problem is only conceived with a time rug. Some people wonder if the global environment will really become worse so serious. Taking this social background it is clear that political leadership is most important as a first step for SPS realization. In Japan, 86 Diet members formed a group in 2003 to promote the space energy strategy. In 2008, Japanese government established "fundamental plan of space utilization" which is most important plan to promote all space utilization in Japan. They announced that the SPS will be included in the plan. This is the first official step to promote the SPS by Japanese

government. The leadership, however, should be taken not only by political world but also by business world because the SPS is a commercial space power system for the sale of electricity from space.

Even after the business world moves toward SPS system, the politics is still important. The SPS industries will be as huge as the other major industries such as car companies, and electric companies. At present there is no effective space law ready for commercialization of the space environment. Frequency regulation for the MPT is one of the most important issues to realize SPS commercial system. Concerning the frequency allocation for SPS, NASA proposed in 1980's to ITU-R (International Telecommunication Union Radiocommunication Sector), on the frequency regulation and allocation for the SPS and the MPT. The role of the ITU-R is to manage the international radio-frequency spectrum and satellite orbit resources and to develop standards for radiocommunication systems with the objective of ensuring the effective use of the spectrum. WARC-79 approved Recommendation 3 calling for studies on the effects on radiocommunications from power transmission from space [8]. Although the work was later dropped due to a lack of activity, Question ITU-R 210/1 concerning the MPT was adopted in 1997 and had been contributed by NASA until 2000. However, there had been no contribution since then. Its deadline of 2005 was postponed in the ITU-R owing to the effort of JAXA and SPS researchers in 2005 [9].

The SPS is one of the most important and hopeful future power stations for the survival of humanity. However, for its realization, there still remain many hurdles before us. A political strategy for the SPS is very important. Serious consideration should be given in many aspects related to the SPS construction and its full use.

REFERENCES

- [1] Glaser, P. E.; "Power from the Sun ; Its Future", Science, No.162, pp.857 - 886, 1968
- [2] Fujita, T., "Concept of Space Solar Power Systems (SSPS) in JAXA", International Union of Radio Science (URSI) General Assembly 2008, Proceedings HBDG Jp2.pdf
- [3] Mankins, J. C., IAF-01-R.4.05, IAA-01-IAA.7.1.01 Oct. 2001
- [4] <http://www.nss.org/settlement/ssp/library/nss0.htm>
- [5] Summerer, L., et al., "Solar Power from Space - Assessment of Potentials for Europe", Proc. of SPS'04, p.26, 2004.7
- [6] Matsumoto, H., "Research on Solar Power Station and Microwave Power Transmission in Japan : Review and Perspectives", IEEE Microwave Magazine, pp.36-45, December 2002
- [7] Shinohara, N., T. Mitani, and H. Matsumoto, "Study on Ubiquitous Power Source with Microwave Power Transmission", International Union of Radio Science (URSI) General Assembly 2005, Proceedings C07.5(01145).pdf
- [8] Information on applications and characteristics of wireless power transmission, Annex 8 to Document No. 1A/32-E, ITU Radiocommunication study groups SG1 WP1A, January 31, 2001
- [9] This is based on a Response to the Question ITU-R 210/1 on wireless power transmission in ITU by the following contribution; JAXA, Document No. 1A/81-E, ITU Radiocommunication study groups SG1 WP1A, September 29, 2005

IV. CONCLUSION

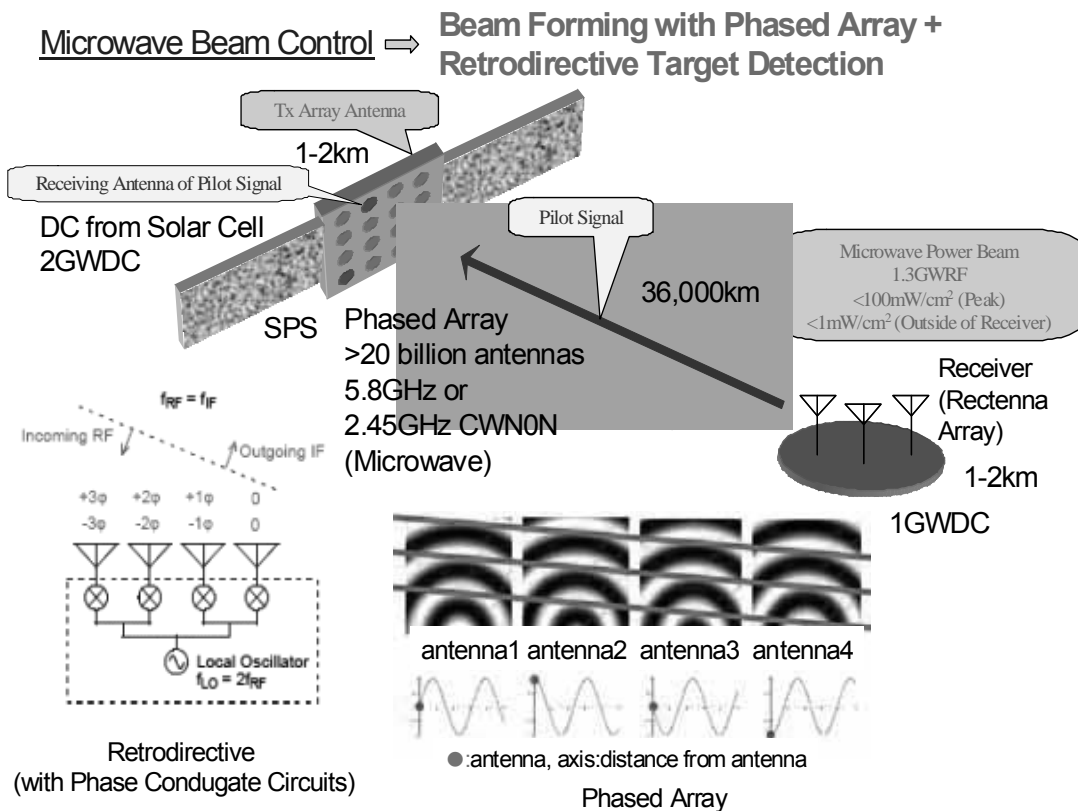


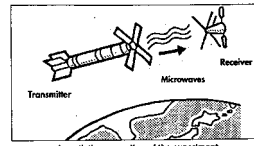
Fig.1 Concept of Space Solar Power Satellite/Station (SPS)



1983
First MPT Rocket Experiment
In the World - MINIX-



1992
MPT Experiment to
Fuel-free Airplane
- MILAX -



**Power Transmission In Space
By Microwaves To Be Tested**

The world's first experiment to transmit energy or power via microwaves from a solar power plant orbiting the Earth to the ground will be conducted Thursday, according to a team of researchers. The researchers from Kyoto University, Kobe University and the Posts and Telecommunication Ministry decided to try using the microwaves because they are suitable for the transmission of energy from space because the waves can travel through rain and clouds without being absorbed. Microwaves are radio waves whose wavelengths fall between one centimeter and 30 centimeters. These waves are used in microwave ovens.

The Thursday experiment will be conducted with the compact S-320 rocket of the Institute of Space and Astronautical Science. The rocket will divide into two units—a receiver and transmitter—at an altitude of 270 kilometers. The parent rocket will be loaded with a 820-kilowatt power transmitter equipped with a wave direction controller, while the smaller rocket will carry a receiver.

During Thursday's experiment, the influence the microwaves have on the ionosphere will also be monitored to check the effect the transmission from space would have on the communication and broadcasting systems on Earth.

1993
Second MPT
Rocket
Experiment
in the World
- ISY-METS -



1996
Retrodirective
MPT System
Open Experiment

Microwaves seen as key transmitters



1994-95
Ground-to-Ground
MPT Experiment

Step toward space-based solar power



2001
Solar Power
Radio Integrated
Transmitter
- SPRITZ -

Fig. 2 Field Experiments Carried Out by Kyoto University

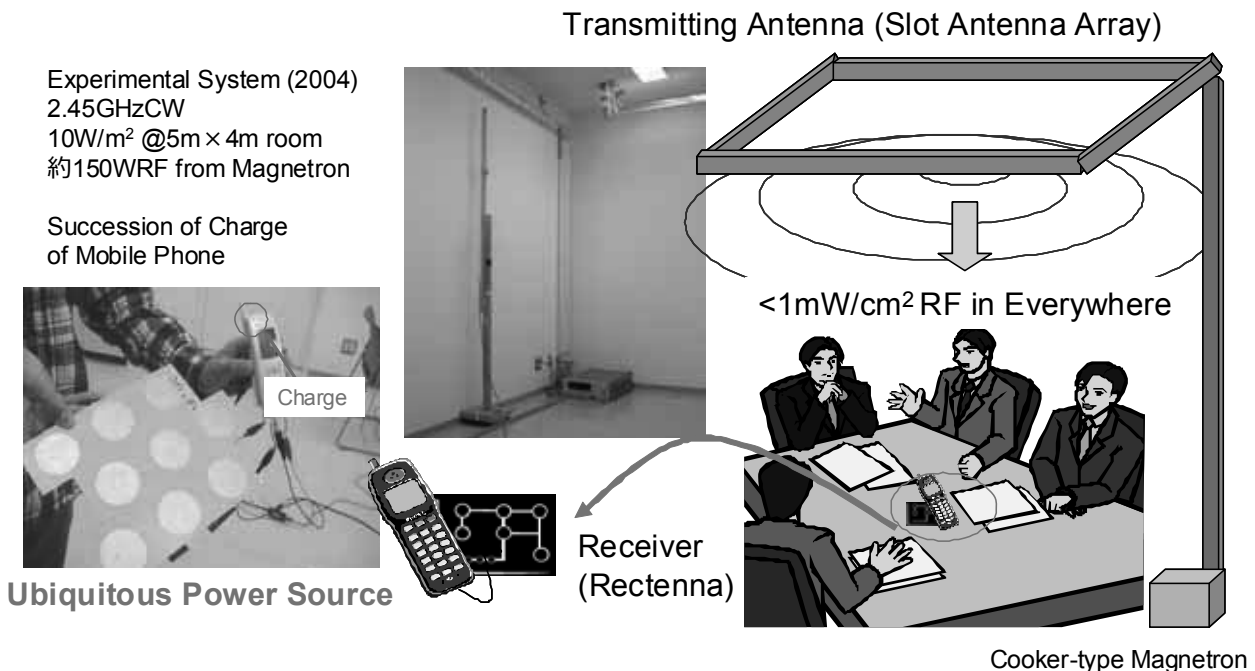


Fig. 3 Ubiquitous Power Source, One Application of Microwave Power Transmission