Wireless Power Transmission with Solar Power Satellite

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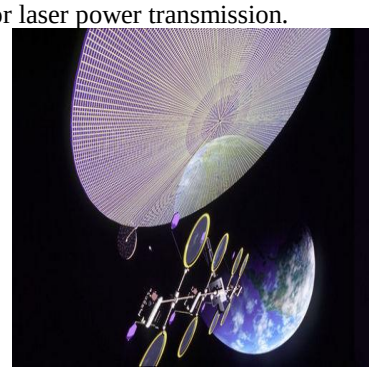
Abstract *--Space-based, solar power generation may become an important source of energy in the 21st Century since energy demand continues to grow along with worldwide concerns over fossil fuel pollution, the safety of nuclear power and waste, and the impact of carbon-burning fuels on global warming. According to a study by the Space Studies Institute (SSI), over 99 percent of the materials needed for building solar power satellites (SPS) can be obtained from Lunar materials. This would reduce the cost of SPS construction by almost 97 percent compared to the alternative of use materials launched from Earth.*

The objective of this paper is to distribute the power to house hold by efficient means when compared to current trend. It says that power can be generated by solar energy directly by sending a satellite of solar panels so that they get the maximum power generated from it and send it to earth so that the same process can be used in our country to supply electricity to households which reduces the usage of wires and greatly prevent power theft and drastic energy wastage.

I. INTRODUCTION

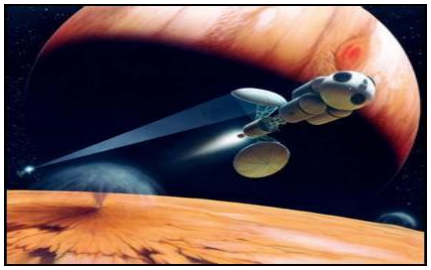
A major problem facing Planet Earth is provision of an adequate supply of clean energy. It has been that we face "...three simultaneous challenges -- population growth, resource consumption, and environmental degradation -- all converging particularly in the matter of sustainable energy supply." It is widely agreed that our current energy practices will not provide for all the world's peoples in an adequate way and still leave our Earth with a livable environment. Hence, a major task for the new century will be to develop sustainable and environmentally friendly sources of energy.

The proposed concept of solar energy conversion in space and wireless power transfer to aircraft can be segmented as follows. First, sunlight needs to be converted to electric energy. Recent research describes either thin-film solar cells or solar dynamic power systems as two possible approaches to this . The next step concerns the transmission of this electric energy. The two main mechanisms for this are either microwave or laser power transmission.



Based on the mode of transmission, the electric energy needs to be converted accordingly. Lastly the transmitted energy has to be converted back to electric energy. Along this process aspects such as conversion efficiency, beam quality, transmission losses, beam steering or pointing quality need to be taken into account.

II. INITIALIZATION OF WIRELESS TRANSMISSIONS



The vision of achieving WPT on a global scale was proposed over 100 years ago when Nikola Tesla first started experiments with WPT, culminating with the construction of a tower for WPT on Long Island, New York, in the early 1900s. Tesla's objective was to develop the technology for transmitting electricity to anywhere in the world without wires. He filed several patents describing wireless power transmitters and receivers. However, his knowledge of electrical phenomena was largely empirical and he did not achieve his objective of WPT, although he was awarded the patent for wireless radio in 1940.

The development of WPT was not effectively pursued until the 1960s when the U.S. Air Force funded the development of a microwave-powered helicopter platform. A successful demonstration of a microwave beam-riding helicopter was performed in 1965. This demonstration proved that a WPT system could be constructed and that effective microwave generators and receivers could be developed for efficient conversion of microwaves into DC electricity.

The growing interest in solar energy conversion methods and solar energy applications in the 1960s and the limitations for producing cost-effective base load power caused by adverse weather conditions and diurnal changes led to the solar power satellite concept in 1968 as a means to convert solar energy with solar cell arrays into electricity and feed it to a microwave generator forming part of a planar, phased-array antenna. In geosynchronous orbit, the antenna would direct a microwave beam of very low power density precisely to one or more receiving antennas at desired locations on Earth.

At a receiving antenna, the microwave energy would be safely and very efficiently reconvened into electricity and then transmitted to users.

Revised Manuscript Received on

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III. TYPES OF WPT

-> Ground based power transmission
-> Space based power transmission
But Space-based power transmission is preferred over Ground-based power transmission. Ground is (obviously) cheaper per noontime watt, but:

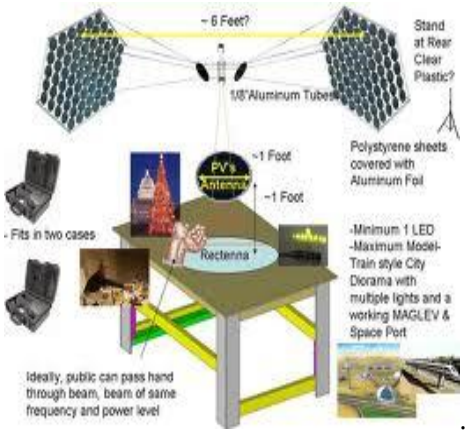
• Space gets full power 24 hours a day
– 3X or more Watt-hours per day per peak watt
– No storage required for nighttime power
• Space gets full power 7 days a week – no cloudy days
• Space gets full power 52 weeks a year
– No long winter nights, no storms, no cloudy seasons
• Space delivers power where it's needed
– Best ground solar sites (deserts) are rarely near users
• Space takes up less, well, space
– Rectennas are 1/3 to 1/10 the area of ground arrays
– Rectennas can share land with farming or other uses.

IV. LIKELIHOOD OF PUBLIC ACCEPTANCE

The stigma of travelling by air polluting aircraft may be remedied. Furthermore, an overall decrease in travel prices is conceivable. Therefore, the acceptance by the travelling as well as the non-travelling public should be high. Impediments on the other hand could arise from the satellite infrastructure in orbit and the beaming mechanism. Depending on the nature of their orbits (low orbit, geostationary orbit) the satellites could be distracting sights on the sky or could be seen as potential threats when it comes to unforeseen de-orbiting in case of failure. Thinking of today's discussions related to electromagnetic "pollution" caused by the mobile phone infrastructure the envisioned wireless power transfer mechanism could also be subject to such discussions. Furthermore, the satellite infrastructure could be perceived as a potential weapon system when thinking of the highly focused energy beams. Possible safety concerns related to dangers connected to the power beam have to be addressed.

V. PROJECTION TO THE FUTURE

Projections 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. All of the scenarios from reference 3 indicate continuing use of fossil sources, nuclear, and large hydro.



However, the greatest increases come from "new renewables" and all scenarios show extensive use of these sources by 2050. Indeed, the projections indicate that the amount of energy derived from new renewable by 2050 will exceed that presently provided by oil and gas combined. This would imply a major change in the world's energy infrastructure. It will be a Herculean task to acquire this projected amount of energy. This author asserts that there are really only a few good options for meeting the additional energy needs of the new century in an environmentally acceptable way
One of the so-called new renewable on which major reliance is almost certain to be placed is solar power. Solar power captured on the Earth is familiar to all. However, an alternative approach to exploiting solar power is to capture it in space and convey it to the Earth by wireless means. As with terrestrial capture, Space Solar Power (SSP) provides a source that is virtually carbon-free and sustainable. As will be described later, the power-collecting platforms would most likely operate in geosynchronous orbit where they would be illuminated 24 hours a day (except for short eclipse periods around the equinoxes). Thus, unlike systems for the terrestrial capture of solar, a space-based system would not be limited by the vagaries of the day-night cycle. Furthermore, if the transmission frequency is properly chosen, delivery of power can be carried out essentially independent of weather conditions. Thus Space Solar Power could provide base load electricity.

VI. BENEFITS OF AIR TRANSPORT SYSTEM

As the finite availability of oil is inevitable, other forms of energy sources become necessary. A more radical approach to this need is the development of a system that directly beams space solar power to aircraft, driving their electrical engines. Implementation of the proposed idea would result in three main benefits. First, an emission-free aircraft could be realized. That is, there will be no more emissions into the upper layers of the atmosphere. Second, weight could be saved as only a small amount of energy relative to the total mission energy demand needs to be carried along. Although additional equipment would be needed for power reception and conversion, weight savings should be substantial. Another potential benefit might be cost savings. In the long run, cost for satellite infrastructure should be less compared to cost for fuel and fuel-related infrastructural needs, especially facing increasing oil production cost.

VII. CHALLENGES

The development and implementation of any new energy source present major challenges. And it is acknowledged that bringing about the use of Space Solar Power on the Earth may be particularly daunting because it is so different. The major challenges are perceived to be:

(1) The mismatch between the time horizon for the implementation of SSP and that for the expansion of conventional natural resources.
(2) The fact that space power is intrinsically global, requiring enterprise models that give every player a suitable stake and adequate safeguards.
(3) The potential for concerns over reliability, safety and environmental implications.
(4) The need to obtain publicly-allocated resources outside the normal purview of the energy community
(5)

The prevailing mind set which tends to view the future energy infrastructure as an extrapolation of the present one

VIII. ADVANTAGES

- Unlimited energy resource
- Energy delivered anywhere in the world.
- Zero fuel cost.
- Zero CO2 emission.
- Minimum long range environmental impact
- Solar radiation can be more efficiently collected in space.

IX. DISADVANTAGES

- Launch cost.
- Capital cost even given cheap launchers.
- Would require a network of hundreds of satellite.
- Possible health hazard.
- The size of the antennas and rectennas.
- Geosynchronous satellites would take up large sections of space.
- Interference with communication satellites

X. CONCLUSION

There is little doubt that the supply of energy must be increased dramatically in coming decades. Furthermore, it appears almost certain that there will be a shift toward renewable sources and that solar will be a major contributor. It is asserted that if the energy system of the world is to work for all its people and be adequately robust, there should be several options to develop in the pursuit of and expanded supply. While the option of Space Solar Power may seem futuristic at present, it is technologically feasible and, given appropriate conditions, can become economically viable. It is asserted that it should be among those options actively pursued over coming decades. The challenges to the implementation of Space Solar Power are significant, but then no major expansion of energy supply will be easy. These challenges need to be tackled vigorously by the space, energy and other communities. Finally, it should be emphasized that if we fail to develop sustainable and clean energy sources and try to limp along by extrapolating present practices, the result is very likely to be thwarted development of economic opportunities for many of the Earth's people and, almost certainly, adverse changes to the planetary environment. The resolve of the synthesis problem of the WPT shows that WPT efficiency may be improved by using special current discontinuous distribution on the antenna.

Here we have three possibilities:

1. To use discontinuous equidistant array with the quasi Gauss distribution.
2. To use a discontinuous non-equidistant array with the uniform distribution.
3. To use uniform continuous phase synthesis antenna array.

All of these methods are original and they have been modeled only in the frame of International Science and Technology Center Project. The possibility of decrease of the wave beam expansion permits to make the WPT systems less expensive. Such approach to the problem of the continuous radiators and of the real antennas, which can be created, is new. Due to high launch costs, SPS is still more expensive than Earth-based solar power and other energy sources. Yet, even now, a small SPS system could be economically justified to provide otherwise unavailable emergency power for natural disaster situations, urban blackouts and satellite power failures.

ACKNOWLEDGMENT

We would like to thank our principal Dr.K.Palanikumar of our college(Sri Sai Ram Institute of Technology) for extending his support in the development of our thesis. We would also like to thank our corresponding Head of the departments A.Anbazhgan of Electrical and Electronics department and G.Thamari Selvi of Electronics and communication engineering for providing us with encouragement and insights in the field of energy resources and wireless transmission.

We would also like to thank our parents and friends who motivated us throughout the entire work.

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