IAF SPACE POWER SYMPOSIUM (C3)
Wireless Power Transmission Technologies and Application (2)

Author: Dr. Lewis Fraas
United States

Mr. Mark J. O'Neill
Mark O'Neill, LLC, United States

A SOLAR POWER SATELLITE SENDING A 1 MW INFRARED BEAM FROM GEO TO CONCENTRATING SOLAR POWER MODULES ON THE GROUND

Abstract

Harvesting solar energy in space from a GEO orbit and RF beaming it down to earth has been a dream since the oil crisis in the 1970's. However, the colossal and expensive first step required to achieve this goal has stifled its initiation. The problem derives from the dispersion of the beam associated with the long RF wavelength leading to a multi km size receiver station and a km size satellite and a costly multi billion dollar development project for a GW sized satellite. Using a shorter wavelength infrared beam reduces the dispersion and ground station size and consequently the satellite size from GWs to MWs. Herein, a satellite with a diode pumped Er:YAG laser generating a MW beam is proposed. The 40 m diameter ground station receives eye safe IR radiation with a 1-sun intensity of one kW per square m. However, the development of a MW size SPS satellite in GEO is still very challenging. The SPS satellite proposed here will require a 70 m diameter mirror array collecting 5 MW of solar energy concentrating it onto a 12 sq m solar cell array which in turn powers the diode laser pumped laser generating the one MW IR beam with a wavelength of 1.55 microns. For the solar panel, the multijunction 40% efficient InGaP/GaInAs/Ge concentrator cells to be used here will be operating at 300 suns. The satellite challenges will be to develop the large mirror array and the MW IR laser as well as the lower cost multijunction cell array with good thermal management. However, the major point in this paper is that the ground station development should be straight forward using modular concentrating solar arrays with 40% efficient GaSb IR photovoltaic cells to generate 400 kW 24 hours per day. GaSb PV cells are made at JX Crystals Inc. Note that in the GEO SPS system proposed here, the ground based concentrating PV modules are simply pointed at a fixed local celestial location in the sky where the GEO SPS is located just as for a direct broadcast TV satellite dish. The satellite location in the celestial sphere does not move at all year around. No tracking is required. The IR concentrating system on the ground can leverage down the PV cell costs. The economics for this concept are described and promising for national security niche power markets.