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SPACE POWER SYMPOSIUM (C3)
Space-Based Solar Power Architectures – New Governmental and Commercial Concepts and Ventures (1)

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SYSTEMS ANALYSIS OF THE SANDWICH SOLAR POWER SATELLITE

Abstract

A detailed systems analysis study of the Sandwich Solar Power Satellite (SPS) is presented here. The unique feature of the Sandwich SPS is the combination of the microwave transmitting antenna (TA) and the photovoltaic (PV) arrays into a single 'sandwich' panel. The TA on the bottom is continually Earth pointing while the PV array layer is on the top. The Sandwich SPS concept eliminates the need for a rotary joint or hub connecting the power generation to the power transmission, which is a particularly high risk component. The power management and distribution system is greatly simplified due to the fact that the power generated must only travel through the thickness of the sandwich panel before being converted to microwaves and beamed to Earth leading to a reduction in transmission lines mass. Additionally, the Sandwich SPS is highly modular in nature, thus increasing the ease of manufacture and reducing cost. Three different architectural options are examined: constellations of SPSs in both LEO and MEO, and the conventional single SPS in GEO. Innovative and advanced technologies are investigated for the supporting systems required for SPS, such as transportation and in-space assembly (ISA). For example, reusable launch vehicles (RLVs) for Earth to orbit transportation are analysed and advanced orbital transfer methods such as space tethers and solar electric propulsion OTVs evaluated. For large commercial scale SPS to be realised, the specific launch cost to LEO must be significantly reduced. This can be achieved by RLVs but only for very high launch rates, which are in any case necessary for SPS. Space tether systems are of interest for SPS as they offer low transfer times and low required propellant mass fraction from LEO to MEO/GEO. ISA techniques which involve high levels of automation using large deployable 'space-webs' and robotic elements for construction are considered. Such techniques are attractive for SPS as they eliminate the need for expensive in-orbit infrastructure and also make the highly modular nature of the Sandwich SPS feasible. In order to realise the commercial scale SPS order of magnitude improvements in both space transportation and ISA methods are necessary. Therefore consideration of advanced concepts in these areas is valid. The predicted performance parameters of the proposed technologies are applied to the three SPS architectures as appropriate. Based upon a comparative study in terms of cost, performance and reliability, a baseline option for the Sandwich SPS is finally selected.