

IAF SPACE POWER SYMPOSIUM (C3)
Solar Power Satellite (1)

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PROPOSAL OF A LOW EARTH ORBIT (LEO) SPACE SOLAR POWER SATELLITE SYSTEM

Abstract

Although various full-scale space solar power satellite models have been proposed by many countries, including Korea, there are still many technical difficulties to overcome at present, in addition to economical justifications. Given this, and taking into consideration the domestic technology readiness and budgetary availability in Korea, the first Korean pilot system for Space Based Solar Power (SBSP) was proposed at the IAC 2022. The system employs two small satellites that utilize formation flight for wireless power transmission (WPT) between two satellites.

In order to meet global commitments to achieve carbon net zero emissions, the primary objective of SBSP is to deliver the electricity generated from solar power in space to the ground. With this goal in mind, the present study proposes a Low Earth Orbit (LEO) space solar power satellite system that is designed to transmit electricity to the ground while considering the constraints of domestic technology readiness and budgetary availability in Korea.

In this study, the practical minimum sizes of the power transmission antenna and the rectenna are proposed initially, to demonstrate that the meaningful solar power can be delivered from space to the ground using present-day Korean technologies, as well as to propose scaling-up designs. The end to end efficiency of solar energy transmission and delivered power, depending on orbit altitudes and angles between the satellite and the rectenna, and total delivered power to the ground per orbit, are then estimated. Next, the power transmission module design, rectenna design for optimal performance, satellite bus specifications, mission design, and operational concept are defined. Furthermore, deployable/expandable devices for the power transmission antenna, solar panels, and booms for communication antennas are introduced. Finally, constellation designs of space solar power satellites for the practical applications, such as emergency power supply for isolated regions, global-scale commercialization, and continuous power supply to the lunar permanent shadow region (PSR), are proposed.