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Wireless Power Transmission Technologies and Application (2)

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EFFICIENT AND COST-EFFECTIVE TECHNIQUES FOR WIRELESS POWER TRANSMISSION: A SIMULATION STUDY ON SPACE-BASED SOLAR POWER

Abstract

Space-based solar power emerges as a renewable energy solution capable of serving as a base load power source, providing continuous rated output 24/7. However, the path to commercializing space-based solar power faces several technological challenges. Among these, the development of long-range wireless power transmission using microwaves is particularly significant. Pioneers such as Raytheon's Bill Brown and NASA's Dick Dickinson achieved a significant milestone in 1975 by retrieving 30 kilowatts DC of power from a distance of 1.55 kilometers, utilizing a 26-meter diameter deep space antenna located at the JPL Goldstone facility Venus Site in the Mojave Desert. These records for the longest distance and maximum power retrieval have persisted for nearly half a century. The obstacles to surpassing these records include the need for large physical sizes of transmission antennas and rectennas to improve transmission efficiency, along with the requirement for high transmission output power, necessitating a considerable budget. Additionally, adherence to radio frequency regulations and the requirement for expansive testing sites pose further challenges. In densely populated countries like Korea, securing vast testing grounds proves to be a challenging task, and stringent electromagnetic wave regulations are not conducive to long-distance power transmission demonstrations. Fortunately, the installation of a 35-meter diameter deep space antenna for controlling Korea's first lunar orbit satellite, 'Danuri,' provides an opportunity to explore cost-effective methods for conducting long-range wireless power transmission tests during non-operational hours of the 'Danuri' satellite. Specifically, deploying a rectenna via an aerostat platform, rather than fixed platforms on the ground, proves to be more budget-friendly and suitable for the Korean terrain. By launching microwaves into the air instead of the ground, the test complies with electromagnetic regulations while avoiding the need for vast land areas. Moreover, by positioning a 55-meter ladder truck on a plateau, successful visualization of power retrieval from a distance of 1.82 kilometers was achieved by capturing the illumination of LED lamps. This study shows promise as a foundational step toward future endeavors aimed at efficiently and cost-effectively renewing records for long-range wireless power transmission.