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ADVANCING SPACE SOLAR POWER SATELLITE: THE ROLE OF ENERGY SATELLITES IN SUSTAINABLE DEVELOPMENT

Abstract

The demand for electricity is increasing rapidly, and it is necessary to reevaluate traditional power generation and transmission paradigms to promote sustainable development. This study focuses on the transformative capabilities of space-based technologies, particularly Space Solar Power Satellites (SSPS) and laser-based power transmission systems. While solar energy has been highly adopted for carbon-free society as a renewable energy initiative on Earth, it is also applicable to space endeavors. Currently, 99.72% of satellites deployed into space rely on solar panels for energy generation. However, the stagnation in solar panel technology over the past 66 years underscores the necessity for innovative alternatives.

The development of a small-sized SSPS holds significant potential in charting a course for the sustainable growth of SSPS technology in the future. This paper provides an updated overview of the Energy Orbit project, highlighting recent advancements in Small SSPS as Energy Satellites (E-Sats) design and development efforts in India and Japan. Employing a Model-Based Systems Engineering (MBSE) approach, this study underscores the potential of E-Sats for efficient space-to-space electricity generation and transmission. Equipped with laser power transmission capabilities, E-Sats offer a new paradigm for meeting the energy demands of satellites in low Earth orbit (LEO), obviating the need for traditional power generation components such as solar panels and batteries.

It also explores critical technical aspects of E-Sat deployment, including laser energy transmission efficiency and satellite propulsion mechanisms utilizing laser beams. The envisaged constellation of E-Sats orbiting Earth, known as Energy Orbit (E-Orbit), promises to establish a robust energy infrastructure catering to customer satellites across diverse orbital altitudes. This innovative approach not only reduces launch costs and satellite weight by 15-25% and 10-25% respectively. Nevertheless, it also extends the operational longevity of satellites. The evolution of Energy Satellites heralds a new era in space-based power transmission, aligning with sustainable development objectives and fostering the addition of space technologies for the betterment of humanity.