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WIRELESS POWER TRANSFER: THE WEAK LINK IN SPACE-BASED SOLAR POWER?

Abstract

Space-Based Solar Power (SBSP) is a concept that revolves around the collection of solar power in space and its transmission for use on Earth. It offers a renewable energy solution with the potential for continuous power output, which is seldom the case with ground renewable energy sources. One of the key advantages of SBSP over terrestrial solar power is the constant availability of solar energy in space. Unlike terrestrial solar, which suffers downtime due to night time and weather variations, SBSP can harvest solar energy 24/7. However, this will only hold true if the system for transmitting energy from Earth's orbit to the ground, which is based on radio wave transmission and is commonly referred to as Wireless Power Transfer (WPT), offers sufficient energy efficiency and availability so that the overall efficiency of the Space-Based Solar Power (SBSP) would remain competitive compared to terrestrial solar power production and distribution. Thus, WPT is the weak link in this technology, as its performance in energy efficiency and availability determines the magnitude of SBSP's advantage over terrestrial solar power. This paper aims at identifying the physical constraints governing the operation of the Wireless Power Transfer (WPT) and to estimate their impacts on performances. After a description of the SBSP energy production and distribution chain, we will list the various power conversion and conditioning processes involved in the chain and evaluate their yields. We will compare the energy efficiencies of each stage of the WPT of various SBSPs that have been studied recently in Europe, USA and China. At last, we will perform a benchmark analysis between space-based solar power with terrestrial solar power in term of annual energy production.