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EFFICIENCY EQUATIONS FOR LONG-DISTANCE WIRELESS POWER TRANSFER USING PHASED ARRAY ANTENNAS

Abstract

This paper examines the efficiency equations typically used to evaluate wireless power transfer and offers a new equation to estimate the efficiency of a multi-antenna array on a realistic scale. This new "common sense" equation is based on the distances involved, the directivity of the antenna, and the geometry of the entire setup, allowing for more realistic efficiencies for a variety of antenna applications. This equation is then compared theoretically to the equations commonly used for wireless power transfer, as well as to previously recorded experimental data, showing a higher accuracy than other equations used today. The "common sense" equation, although widely applicable, does view the transmitting antenna array as a point source. To verify the validity of this assumption, the far-field distance for phased array antennas is also considered. Because the far-field equations typically used are also based on a singular antenna, the distance required for the antenna array to be viewed as a point source within an acceptable amount of error is discussed. The implications of this result in terms of space solar power of various distances is explored. This equation is then applied to the SSP setup to offer a realistic view on the maximum efficiency of the wireless power system, which is the main contributor to the efficiency of the system as a whole. This analysis will be applied to determine nominal dimensions for spacetennae and terrestrial rectennae for 2.45 and 5.8 GHz wireless power transmission. These results provide a more realistic estimate for sizes and performance relative to current practice, which can greatly benefit the space solar power community.