Wireless Power Transfer in a Novel Solar Power Satellite System Architecture

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Solar power satellite (SPS) systems can revolutionize energy distribution by capturing solar energy in space and wirelessly transmitting it to ground receivers [1]. This method promises a continuous and reliable power supply, mostly unaffected by weather or day-night cycles. However, the vast distance between the satellites and the Earth presents a challenge, requiring large and precise infrastructures to be built and maintained in space. William Brown's work on wireless power transfer (WPT) by microwaves paved the way, while highlighting the complexities of achieving high-efficiency over such distances [2].

Researchers at the University of Aveiro have proposed an innovative system architecture that addresses several of these challenges [3]. The main novelty is the addition of an energy storage subsystem, allowing power supply even if there is no direct sunlight, such as lunar bases on the dark side of the moon. Additionally, to enhance the WPT's efficiency and reduce the system's dimensions, quasioptical techniques focus the beam of energy, done here mostly with lenses [4, 5, 6]. Finally, solar concentrators increase the energy generation efficiency [7].

This project has achieved significant milestones, having won an European Space Agency Ideas call, for the development of a large-scale ground demonstrator. Preliminary results have shown a beam transfer efficiency of 43%, surpassing the state-of-the-art.

Key developments in the beam transfer include new corrugated horn antennas and miniaturized Fresnel zoned lenses. The former can be additively manufactured directly in metal without supports, while providing excellent radiation performance. The miniaturized Fresnel lens significantly reduces the lens' thickness and overall system weight, dimensions and costs.

In summary, this research represents a major advancement in SPS systems, addressing key technical challenges, bringing us closer to realizing SPS as a viable energy solution.

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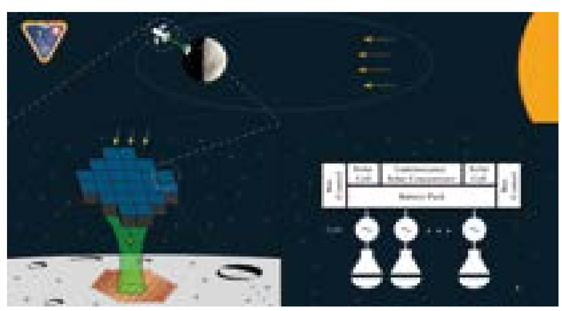

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FIGURE 1
Schematic of the solar power satellite system proposed by UA.

FIGURE 2
Preliminary experimental setup achieved, where a beam efficiency of 43% was achieved with the proposed novel solutions.