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# DIANA'S MIDNIGHT SUN: SUSTAINABLE ENERGY SOLUTIONS WITH SOLAR POWER SATELLITES FOR DIANA LUNAR INFRASTRUCTURE

**Abstract**

Establishing an energy infrastructure to support lunar resource extraction and long-term colonization

poses significant challenges. Recent research underscores the necessity of gigawatt (GW) scale energy generation to sustain autonomous lunar colonies over extended durations. Terrestrial energy systems face shortcomings in meeting the energy demands of large-scale infrastructure. Exemplarily, terrestrial solar modules necessitate significant space allocation due to their maximum energy output of approximately 10 kW per module. Furthermore, nuclear reactors present sustainability challenges. Moreover, reliance solely on terrestrial energy systems would exponentially escalate the frequency of required rocket launches, posing logistical and sustainability concerns. In response, the DIANA (Dedicated Infrastructure and Architecture for Near-Earth Astronautics) energy infrastructure concept was proposed in 2023, advocating for the utilization of lunar perovskite solar cells to mitigate the reliance on frequent rocket launches and enhance sustainability. However, due to the suboptimal illumination conditions prevalent in the lunar south-polar region, the envisaged perovskite solar park would necessitate an extensive footprint of approximately 400 $km^2$. This requirement poses positioning, energy transmission, transportation, and resource utilization challenges.

A novel concept is imperative to address these challenges and significantly reduce the solar panel area requisite for lunar infrastructure. It will enable the utilization of solar panels during shadow phases or in proximity to the lunar base, thereby minimizing distances and increasing operational efficiency.

A promising solution to achieve this objective involves the deployment of solar power satellites orbiting the Moon. These satellites harness solar energy under favorable lighting conditions throughout the year and transmit it wirelessly to passivesolar modules during shadow phases. Such an approach optimizes solar park utilization, leading to a reduced lunar surface area requirement. Furthermore, this infrastructure offers the added benefit of conserving resources by minimizing the need for extensive solar panel manufacturing.

Consequently, this paper will explore the feasibility of implementing the ZEUS satellite constellation to facilitate efficient energy generation and provide redundancy in case of panel failures, ensuring an uninterrupted energy supply for lunar operations. This constellation concept can have implications for sustaining extra-terrestrial architecture for longer periods, opening up new avenues for large-scale research initiatives.