Paper ID: 100979
interactive

IAF BUSINESSES AND INNOVATION SYMPOSIUM (E6)
Interactive Presentations - IAF BUSINESS INNOVATION SYMPOSIUM (IP)

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AN ECONOMIC IMPACT ANALYSIS FOR SPACE-BASED SOLAR POWER SYSTEMS ON THE WORLD'S ECONOMY

Abstract

Space-based solar power (SBSP) has long been considered a promising solution for continuous and reliable energy generation. Beyond its technological feasibility, SBSP has the potential to drive significant socio-economic transformations on Earth's economy. This study conducts a techno-economic analysis of SBSP, tailoring the Levelized Cost of Energy (LCOE) methodology to account solely for the generation component of SBSP. The model incorporates key cost parameters, including manufacturing, launch, assembly, deployment, solar panel fabrication and encapsulation, maintenance (considering space-based wear and tear, launching, and assembly costs), fuel for deployment and orbit correction, end-of-life costs, and environmental impact.

A probabilistic Monte Carlo analysis was conducted to estimate the cost of SBSP energy generation, yielding a range between 53/$MWhand$158/MWh under scenarios that assume flexible technologies, particularly for launch. This places SBSP theoretically within the range of terrestrial solar power generation costs, which typically vary between 20/$MWhand$60/MWh. Notably, this study's Levelized Cost of Space Energy (LCOSE) explicitly incorporates lifecycle emissions costs, unlike many terrestrial LCOE calculations, offering a more comprehensive assessment of environmental impact at the expense of higher overall cost figures. However, it excludes the costs of satellite structural components and ground infrastructure, which are typically included in terrestrial LCOE models.

The findings highlight that launch costs overwhelmingly dominate SBSP's total cost, exceeding all other assessed categories combined. Consequently, reducing launch costs is the most effective strategy for improving SBSP's economic feasibility. Additionally, SBSP could provide dynamic energy allocation, allowing satellites to shift energy transmission between different terrestrial receivers in response to fluctuating demand across geographic regions. This capability has profound implications for global energy markets, particularly in regions with high variability in consumption patterns.

The potential economic benefits of SBSP extend beyond energy markets. Its deployment could reduce dependence on terrestrial energy sources, drive innovation in renewable energy infrastructure, and create new economic opportunities in the space sector. Moreover, SBSP aligns with climate goals, offering a near-continuous renewable energy source unaffected by atmospheric conditions, which could play a critical role in achieving net-zero emissions targets outlined in the Paris Agreement.

This study provides valuable insights for policymakers, industry leaders, and researchers, supporting informed decision-making on the viability of SBSP as a competitive and sustainable energy solution for Earth's future energy landscape.