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SPACE BASED SOLAR POWER TO ADDRESS CLIMATE CHANGE WITH IMPROVED ECONOMICS ENABLED BY REFUELING

Abstract

Space-based solar power (SBSP) platforms have the potential to provide a solution for future energy generation with minimal carbon footprint, decreasing the detrimental effects of climate change. These solutions leverage the higher energy concentrations and access possible for space-based energy collection as well as the potential to deploy solar panels with large areas in space to maximize solar energy generation. Unfortunately, these advantages also come with significant challenges; the large areas present difficulties for manufacturing such systems and increase the effects of both atmospheric drag and solar radiation pressure. The former consideration drives a need for SBSP systems to be assembled in space to produce a final collection area that is larger than what can be delivered to space in one piece by current launch vehicles, while the latter introduces a significant need for SBSP systems to expend fuel for station keeping maneuvers, reducing their orbital lifetime. Both of these effects result in SBSP systems having an extremely large cost per kilowatt hour, leaving this potential climate friendly energy solution uncompetitive with high-emissions terrestrial alternatives.

In-space refueling is capable of mitigating both major challenges to the deployment of SBSP infrastructure. This paper quantifies the potential cost reductions for the deployment and maintenance of SBSP platforms achievable using refueling. Refueling is a key enabler for in-space assembly; by refueling and reusing assembly vehicles, the total number of launches assembly spacecraft needed can be significantly reduced, accelerating deployment of SBSP spacecraft and reducing costs. Additionally, access to a plentiful fuel supply will enable orbit maintenance and momentum management over extended periods without needing to carry unrealistically large volumes of propellant on-board, further reducing the cost of SBSP systems. This enables significant reductions in the cost per kilowatt hour of energy from SBSP, removing one of the biggest obstacles to economic viability of these systems. The paper then compares the achievable cost per kWh and CO2 production over time of SBSP with those of terrestrial energy sources to show how refueling can make SBSP a competitive and sustainable energy solution. The results indicate that funding such initiatives will be significantly more feasible if refueling in-space is included in mission plans from the beginning. Lastly, the paper outlines the refueling architecture Orbit Fab is building and how it would effectively support a space-based solar power ecosystem.