IAF SPACE POWER SYMPOSIUM (C3)
Solar Power Satellite (1)

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CLIMATE ACTION AND GROWING ELECTRICITY DEMAND: MEETING BOTH CHALLENGES IN THE 21ST CENTURY WITH SPACE-BASED SOLAR POWER DELIVERED BY SPACE ELEVATOR

Abstract

The impact of climate change on human habitats is projected to be substantial in the coming decades. Contributing to the difficulty of mitigating this impact are the ever increasing electricity demands of the world's economies, projected to increase nearly 70% by 2050. Both climate change and increasing demand for electricity are problems that need to be solved simultaneously to ensure the future of a habitable planet. Space-based solar power (SSP) presents such a solution.

Recently, Japan and China have committed to carbon-neutrality by 2050 and 2060, respectively, with South Korea, the United States, and the European Union declaring similar intentions. SSP, with its high output and availability compared to terrestrial solar power, can enable such ambitions. However, the largest barrier to deployment has been economic viability: the SPS-ALPHA Mk-II, the lightest of the proposed 2 GW systems, requires 10,000 tonnes to GEO. This quantity is of the same order-of-magnitude as the total payload humanity has launched to orbit and beyond to date. With the aggressive launch schedules being pursued by SpaceX and others, however, rockets may be able to deploy such systems as early as the next decade.

But for SSP to have an impact compelling enough to join the portfolio of climate change mitigation technologies, it will have to be deployed on a scale far beyond what rockets are likely to deliver in this century. Nearly 3,500 launches of a 20-tonne-to-GEO vehicle would be required every year starting in 2030 to meet 1/8 of global electricity demand by 2100. We show that such scales could be met and and even exceeded by space elevators, meeting up to 1/8 of global electricity demand by 2068 with 3.6M tonnes at GEO, and up to 1/4 by 2100 (4.9M tonnes). A space elevator development program like that proposed by ISEC would yield the massive throughput required to enable an aggressive SSP deployment program.

Although rockets are poised to deploy the first SPS ystem in the near future, and continue to prove their use for opening up new activities in space, space elevators are a complementary technology for high-throughput movement of freight to GEO and beyond. With a near-constant projected transport throughput of 79 tonnes per day at full operating capacity for a single system, a space elevator is the transport system best suited for deployment of megasystems such as SSP–addressing both the climate crisis and rising electricity demand simultaneously.