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

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A PROCESS-BASED LIFE CYCLE SUSTAINABILITY ASSESSMENT OF THE SPACE-BASED SOLAR POWER CONCEPT

Abstract

Since the 1970s, research into the space-based solar power (SBSP) concept has received considerable international attention as an alternative renewable energy source to conventional ground-based solar power. The technology has traditionally been marketed as having great potential to assist in the fight against climate change by helping to transition away from fossil fuels. This is because there are no conceivable emissions attributable to the utilisation phase of SBSP since it operates in outer space. However, this ignores the environmental impacts arising from other areas of its life cycle such as raw material extraction, production & manufacturing and launch. Additionally, no in-orbit demonstrations have ever taken place which is primarily fuelled by the high initial upfront investment costs. The risks involved with providing this level of funding for an unproven technology has meant that the SBSP concept has been stuck in a perpetual, vicious cycle. Therefore, in order to obtain the necessary levels of investment to break this and kick-start the industry, it is vital that the viability of the SBSP concept as a renewable energy option can be scientifically and quantifiably proven.

In order to be considered as a truly viable renewable energy technology, it can be considered that there must be a clear environmental benefit of pursuing this option. Additionally, the price of energy must remain comparable to terrestrial-based generation systems. For this reason, a process-based life cycle sustainability assessment (LCSA) study was conducted to identify the life cycle environmental, economic and social impacts of the DOE/NASA Solar Power Satellite (SPS) 'Reference System'. This was only the third ever LCSA study for space systems to be performed worldwide and was applied using a new LCSA tool for space missions developed at the University of Strathclyde. Taking a burden-based approach, the tool has been used to calculate environmental impacts across a wide range of different environmental impact categories and quantify costs over the system life cycle. The inclusion of social impacts adds additional depth to the analysis by showcasing the sociological impacts of the system on various stakeholder groups in line with the 2030 Agenda for Sustainable Development. The life cycle CO_2 emissions and costs are then compared to terrestrial energy generation systems in order to benchmark the relative performance of the technology as part of the conventional energy mix. It is proposed that these results are used as a baseline for comparison to continually improve future SPS designs.