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METRICS FOR GLOBAL EMISSIONS REDUCTION USING SOLAR POWER BEAMED FROM ORBIT

Abstract

Baseload electric power can be collected in orbit and transferred wirelessly to receiving antennae on Earth. At scale, this technology, called Space Solar Power (SSP, also known as Space-Based Solar Power, or just Space Solar) has a smaller environmental foot print than electricity from uranium, coal, and natural gas. SSP is even superior to terrestrial wind and solar when applied to baseload ("always on") power, which requires energy storage due to their non-dispatchable (intermittent) nature. This work addresses reductions in global emissions in CO2-eq realized as a function of scale-up for SSP versus traditional sources of utility-scale energy generation. As with ground-based wind and solar, SSP has zero fuel costs. However, SSP requires that a significant mass is placed into orbit – a process that is very energy intensive. This study explores energy payback time, and Energy Returned on Energy Invested (EROEI) as a technology-neutral means of comparing various baseload sources of electric power at the magnitude suitable for direct grid-tie delivery into the transmission and distribution system of a region or country. SSP also requires a sizeable footprint for the receiving antenna ("rectenna"), such that its construction must be included in an inventory of direct and indirect atmospheric emissions of greenhouse gases (GHGs). Furthermore, the electromagnetic beam passing through the atmosphere has a small but non-negligible contribution to global warming, and must be included. SSP researchers have identified as many as 31 different methods (called "architectures"), however, this study will use representative benchmark metrics that can be adjusted easily when applied to alternate approaches (e.g. specific mass of a powersat at 6 kW/kg). Finally, this work will explore a second-generation SSP in which most (95%+) of the needed materials are obtained from in situ resource utilization (ISRU), meaning that solar panels, structural elements, and power electronics are derived from lunar or asteroidal materials. The "Gen 2" approach dramatically leverages factories built on Earth that produce tens or hundreds of times their own mass in SSP materials. This represents perhaps the lowest overall global emissions scenario for anticipated future human energy needs, and presents the case for vigorous support of research, regulation, and international cooperation on this important emerging technology.