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CASSIOPEIA – A NEW PARADIGM FOR SPACE SOLAR POWER

Abstract

Recent debate (Clack v. Jacobson, 2017) argues the feasibility of 100% terrestrial renewables (wind, water, solar) by 2050, on the premise of restricting world consumption to 2012 levels (12 TW-years). Given the expected population rise by 3 billion over the same time frame, and the correlation between prosperity and energy availability – are we to impose energy equality, requiring some to reduce consumption by 87%, or are we to condemn the majority to relentless poverty? Choosing neither implies ever-increasing carbon emissions and the risk of catastrophic climate change. Nuclear fission is one energy technology which could be expanded to provide sufficient carbon-free power, but faces widespread opposition from public fear and distrust. Future terrestrial fusion is another, but first pilot operations are not expected until 2050 – which may be too late. We could make much better use of one existing fusion power source, our Sun. The fundamentals of Space Solar Power (SSP) are well understood and could lead to a world of energy abundance; the deliverable power from just a 10km geostationary (GEO) band exceeds 570 TW-years – enough to supply ten billion people at six-times current US per-capita levels. Despite this, SSP has languished for nearly fifty years. GEO is one rare candidate for baseload power, but physics dictates a kilometre-scale microwave transmitter irrespective of the power delivered – hence economics favours the multi-gigawatt (per-satellite) engineering limit. Given the complexity of the differentially rotating solar collector, sub-gigawatt SSP suffers both economically and technically, with different solutions required at different scales – which has led to exorbitant (hence prohibitive) start-up costs. CASSIOPeiA breaks this non-scaling paradigm by eliminating the rotating interfaces; all SPS subsystems are able to share one lightweight modular structure, with near-invariant areal power density from sub-megawatt to gigawatt systems. With additional fixed mirror concentrators, CASSIOPeiA can also be expanded into the multi-gigawatt regime. CASSIOPeiA's unique beam-steering capability facilitates baseload delivery from alternative, closer orbits, with the possibility of single payload deployment requiring no on-orbit assembly. By starting with sub-megawatt, near-term stratospheric station-keeping platforms – with retrieval, servicing and transfer of gained knowledge – the era of SSP may commence at much lower risk and expense.