SPACE SYSTEMS SYMPOSIUM (D1)
Innovative and Visionary Space Systems Concepts (1)

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HELIODROMUS: RENEWABLE ENERGY FROM SPACE

Abstract

Climate change and the related running out of fossil fuel reserves drives the development of renewable energy sources. To contribute to a solution to these problems, we present the results of a design synthesis project on Space Based Solar Power (SBSP). SBSP generates power in space using solar cells concentrator systems and wireless power transmittance to Earth. Main advantages compared to terrestrial solar conversion systems are a higher surface power density and continuous power supply. The project includes an analysis of the current and future electricity market, its technical performance, the conceptual design of a SBSP system, the economical aspects and sustainability. The SBPS top level requirements are an operational lifetime greater than 10 years, an end of life effective power output on Earth exceeding 1 GW, a launch before 2025 and being cost-competitive with terrestrial energy sources. Besides these top level requirements, numerous derived requirements are established on sustainability, safety and (subsystem) design. The SBPS concept, termed Heliodromus, resulted from a broad study starting with three existing concepts. A systems engineering trade-off resulted in a (non-existing) new concept: a constellation of ten satellites orbiting in Low-Earth Orbit and two satellites orbiting in geostationary Earth orbit each having five mirrors. The performance of Heliodromus was evaluated by the following criterea: overall efficiency, technical readiness levels , energy payback time and total cost. The major losses occur during the initial energy conversion, with only 15% efficiency, by the photovoltaic thin films. Heliodromus is 5 to 10 times more expensive compared to existing Earth based solar farms, both photovoltaic and solar dynamic. The energy payback time is 6 years compared to 3 years for terrestrial solutions. A worst case estimate of Heliodromus' efficiency is 2% which is not sufficient to compete with Earth-based solar systems. The electricity cost is 1 $ per kWh compared to 0.08 $ per kWh for a terrestrial power plant. The cost of Heliodromus is around $98 billion and at this stage it is not price-competitive with fossil or Earth-based renewable energy sources. Assembly in orbit was never done on the scale required for Heliodromus, therefore it opens totally new fields of research and development. The total efficiency was defined worst case and the improvement of electronic components efficiency will continue. Therefore a factor 4 improvement in the near future is probable, getting Heliodromus close to becoming market viable.