The Space Power Grid: Synergy Between Space, Energy and Security Policies

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The dream of Space Solar Power (SSP) is that abundant, clean, steady electric power can be generated "24/365" in Space from solar energy, and conveyed down to Earth. This has remained a dream because of the massive cost to first power implicit in all concepts that involve building large collector-converter satellites in Geosynchronous Earth Orbit (GEO) or beyond. The Space Power Grid (SPG) approach (Komerath, 2006,08,09) breaks through this problem by showing an evolutionary, scalable approach to bringing about full SSP within 25 to 30 years from a project start today, with a viable path for private enterprise, and minimal need for taxpayer investment. This paper deals with the interplay of technology, economics, global relations and national public policy involved in making this concept come to fruition.

Briefly, the SPG approach is a 3-phase process to bring about full SSP. In Phase 1, no power is generated in Space. Instead, Space is used as the avenue to exchange power generated by renewable-energy plants located around the world. This is a breakthrough because renewable power plants today are unable to compete with local alternatives such as nuclear and fossil thermal power, due to their inherently unsteady, fluctuating nature. The sun only shines during the day, and not very well in cloudy weather, on Earth's surface. Wind power fluctuates wildly. The ideal locations for wind, solar and tidal/wave power plants are typically far from their customers, hence demanding the installation of new high-voltage power grids in an age when land rights and environmental impact policies impose high costs on such infrastructure. In addition, to qualify for "baseload" status, renewable power plants must install auxiliary power generators amounting to essentially 100% of their standard capacity, in order to be able to guarantee a steady level of output, and the ability to respond to demand surges. Such auxiliary generators are usually fossil burners, and relatively inefficient.

The Phase 1 SPG provides a small constellation of satellites, in 2000 kilometer-high orbits (Low to Medium Earth Orbit), acting as waveguides for beamed millimeter wave power from plants during peak production, sending power to their counterparts where the sun is not shining or the wind not blowing. The SPG also opens up global markets to these new plants, including islands and remote areas where electric power commands much higher prices than it does in developed areas served by the terrestrial power grid. Thus, even the low efficiency of beamed transmission is justified by the access to places where high prices are received.

Our group has refined the technology status and needs as well as the cost and business viability estimates of this concept. Detailed calculations of Net Present Value and the Return on Investment (ROI) needed for breakeven in a set number of years, have shown (Ref. 3) that a power cost of 30 cents per KWh can be achieved, breaking even with

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reasonable ROI within 23 years from project start, given the first satellite launch in year 6. This is with zero government funding. With about $6B invested during the development phase, this can be achieved even if system efficiency does not improve much from what is possible today.

The economics of Carbon Credits and control of global Climate Change improve the viability of the SPG, since the new plants replace fossil generated power, while the SPG eliminates the need for thousands of miles of concrete and metal transmission grids that take an enormous amount of energy to develop.

Once the Phase 1 SPG is in place and essentially self-sustaining by synergy with the renewable power industry, the satellites are gradually replaced, as each reaches about 17 years of age, with new, larger Phase 2 satellites that incorporate collector-converters for solar power, using the technological advances of the 23 years since project start. These put a small amount of space-generated power into the already-functioning grid, at a much lower generation cost. Phase 3 consists of launching several very large, but ultra-light collector/ reflector satellites to high orbits. These will contain no converters (thereby reducing their mass by 2 orders of magnitude) but simply collect and focus sunlight on to the Phase 2 collector-converters in L/MEO. Phase 3 then allows for expansion until the constellation in L/MEO reaches saturation. To double terrestrial primary energy availability, some 300 square kilometers of ultralight reflectors will be needed, in high orbits.

Such a system involving global power exchange obviously requires international collaboration on a global scale. Komerath (2007) proposes a global public-private Consortium, partially based on the model for the European Space Agency, where member nations and private corporations collaborate to reduce risk, make low-interest funding available, and organize the construction of major Space infrastructure. This set up is also shown to be open a path towards resolving some of the most vexing obstacles in space resource utilization, arising from current Space Law. On a national level, moving towards the Space Power Grid approach requires some fundamental realignments that synergize the Space and Energy enterprises with the environmental / Climate Change control movement. These issues are studied in the proposed paper.

References:

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