mPower TECHNOLOGY

SPACE-BASED SOLAR POWER

AN MPOWER TECHNOLOGY WHITE PAPER

Corporate Office

5901 Indian School Road
Albuquerque, NM 87110

Email: info@mpowertech.com
Website: www.mpowertech.com

ENERGY - THE FUNDAMENTAL ENABLER FOR ACTIVITY IN SPACE

Humankind is turning its attention to space again with renewed ambition and investment, and along with this will surely come an ever-increasing need for energy and for power. It is the fundamental enabler for all activity in space. Life support, communications, mining, propulsion, sensors, surveillance and security – none of these happen in space without power. Historically, power has been provided by solar panels (or in some rare cases, radioactive generators or RTGs) that are attached locally to satellites or space stations. But, as the need for power increases and the applications expand, a more scalable and flexible form of power generation and distribution will be needed (much as it is on Earth with the power generation and distribution systems).

To address this need, space-based solar power (SBSP) generation and power beaming systems are rapidly gaining global momentum. These SBSP systems have been proposed and analyzed for over 50 years, with first concepts dating back even earlier. Until recently however, the economics were prohibitive, and the critical technologies were either undeveloped or nascent. But this has rapidly changed, motivating most developed countries around the world to aggressively expand investments in SBSP and conduct well-funded feasibility studies with large infrastructure engineering firms. Organizations such as NASA, Caltech/JPL, AFRL, Northrop Grumman, Lockheed, ESA, JAXA and many other international research teams are now seeking to develop SBSP systems that can not only provide a centralized source of energy for space missions, but also eventually deliver a clean sustainable source of energy back on Earth, particularly in remote areas where power lines cannot easily reach.

With the rapid decline in launch costs (~$2,000/kg moving to below $100/kg with SpaceX/Starship) and the emergence of in-orbit assembly and construction, large-scale SBSP systems (100MW – 1 GW+) are becoming not only possible, but economically viable. These SBSP systems (analogous to utilities on Earth) will be the key enablers for the future of Space 2.0.

To make SBSP systems a reality will require a low-cost, lightweight, highly scalable source of power that is resilient, requires minimal maintenance and is radiation tolerant. Enter DragonSCALES™. DragonSCALES is perfectly suited for SBSP systems and offers an unmatched set of combined advantages, whether using optical laser or microwave beaming. Consider the following benefits of DragonSCALES:

LOW COST

Given the scale required, SBSP systems require an extremely low-cost source of power to become economically feasible. DragonSCALES modules combine low-cost terrestrial silicon cells at <$0.25/watt with high-volume microelectronics assembly processes. The result is highly cost-effective modules and photovoltaic arrays that are three to five times cheaper than traditional gallium arsenide (GaAs)-based solutions. In addition, given they come pre-wired and minimize touch labor, DragonSCALES modules dramatically simplify downstream wing level assembly and integration, yielding additional dramatic cost reductions at the spacecraft/platform level. Finally, since they are inherently flexible, they allow unique stowage, deployment and operation configurations which can further reduce the cost of launch and operation.

LOW MASS

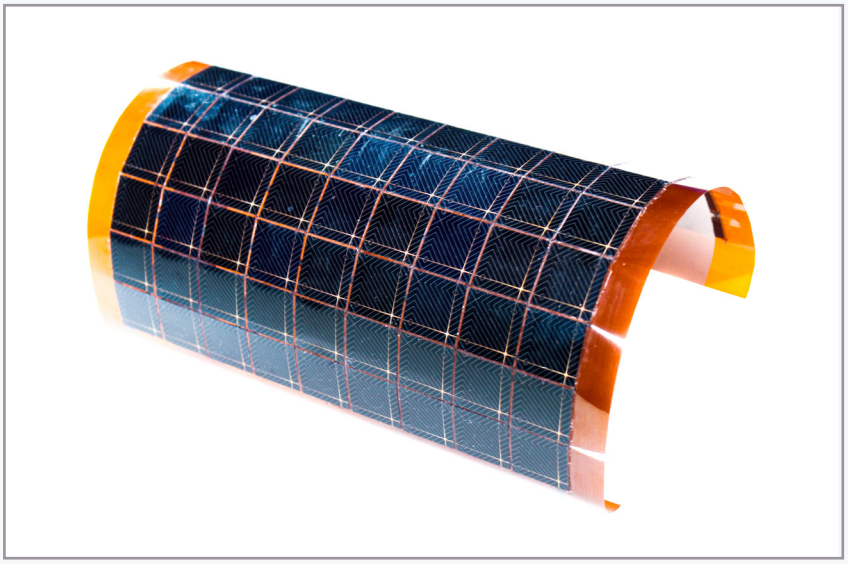
Given their size and scale, SBSP systems also need to be light weight. DragonSCALES modules use silicon, which is half the density of GaAs, and minimize interconnect mass. Furthermore, since the modules are flexible and resilient, they enable thin substrates and tensioned/framed modular structures. The resulting SBSP system can realize significant mass savings (more than 25%) over a traditional approach.

EXTREME SCALABILITY

Full-scale SBSP systems will need to be massive, eventually reaching one gigawatt (GW) or more. DragonSCALES modules are based on terrestrial silicon cells that are readily available off the shelf with annual volumes exceeding 200GW per year in 2022 and increasing at >30% per year. Optimized DragonSCALES modules and structures for SBSP can be built and deployed rapidly at gigawatt per year scale within 12-24 months.

RESILIENCE

Space-based solar power systems need to be resilient to ensure long operating life and increased system reliability. Using massively parallel and redundant interconnects, DragonSCALES can withstand mechanical damage from micrometeoroids, orbital debris and other sources and are shade tolerant.



RADIATION RECOVERY

To provide required mission life and operating efficiency, SBSP systems require protection against the damaging effects of radiation. For many of the target orbits, DragonSCALES cells recover close to 100% of initial efficiency at nominal operating temperatures. With a nominal "anneal/refresh" cycle every one to two months, DragonSCALES modules can be operated for 15-20 years or more, reducing the need for replacement and lowering overall cost of ownership and levelized cost of electricity (LCOE).

MODULARITY

To reduce cost and increase reliability, SBSP construction and maintenance need to be as simple as possible. DragonSCALES allows each 'segment' to be constructed with a highly parallel, redundant, and resilient architecture. It can be flown in formation and easily 'snapped-in' and 'snapped-out' for repairs and/or replacement. Embedded components, such as high-voltage power electronics within the segment structure, allow simplified control, and provide higher reliability and less conductor mass.

POWER BEAMING

With the same module, DragonSCALES modules can provide both solar power generation and beamed power capture with high efficiency. Other systems are optimized for one or the other, but not both. Levelized cost of delivered energy (electricity) is the key metric, and DragonSCALES clearly provides the most attractive overall system configuration.

mPower has already demonstrated DragonSCALES' key enabling capabilities with its current products (high voltage, resilience, radiation recovery, scalability). We are looking forward to rapidly scaling with our partners to help make SBSP a reality and provide clean, affordable power not only in space, but also here on Earth.