NASA SBIR 2019 Phase I Solicitation

S3.01 Power Generation and Conversion

Lead Center: GRC

Participating Center(s): ARC, JPL

Technology Area: TA3 Space Power and Energy Storage

Photovoltaic cell and blanket technologies lead to significant improvements in overall solar array performance by increasing photovoltaic cell efficiency greater than 30%, increasing array mass specific power greater than 300W/kg, decreased stowed volume, reduced initial and recurring costs, long- term operation in radiation environments, high power arrays, and a wide range of space environmental operating conditions are solicited.

Being sought are proposals that show advances in, but not limited to, the following:

- Photovoltaic cell and blanket technologies capable of low intensity, low-temperature operation applicable to outer planetary (low solar intensity) missions.
- Photovoltaic cell, and blanket technologies that enhance and extend performance in lunar applications including orbital, surface, and transfer.
- Solar arrays to support Extreme Environments Solar Power type missions, including long-lived, radiation tolerant, and cell and blanket technologies applicable to Jupiter missions.
- Lightweight solar array technologies applicable to science missions using solar electric propulsion.

Current missions being studied require solar arrays that provide 1 to 20 kilowatts of power at 1 AU, greater than 300 watts/kilogram specific power, operation in the range of 0.7 to 3 AU, and low stowed volume.

These technologies are relevant to any space science, earth science, planetary surface, or other science mission that requires affordable high-efficiency photovoltaic power production or radioisotope heat sources for orbiters, flyby craft, landers, and rovers. Specific requirements can be found in the references listed below but include many future SMD. Specific requirements for orbiters and flybys to Outer planets include: LILT capability (>38% at 10 AU and <?140° C), radiation tolerance (6e15 1 MeV e-cm^2), high power (>50 kW at 1 AU), low mass (3× lower than SOP), low volume (3× lower than SOP), long life (>15 years), and high reliability.

These technologies are relevant and align to any Space Technology Mission Directorate (STMD) or Human Exploration and Operations Mission Directorate (HEOMD) missions that require affordable, high-efficiency photovoltaic power production. NASA applications for a radioisotope heat source include orbiters, flyby craft, landers, and rovers.

Expected TRL for this project is 3 to 5.

Dynamic Power Conversion

For space applications where solar power is not practical, power convertors are used to convert heat to electrical power with dynamic engines combined with alternators typically providing significantly higher efficiency than current static devices. Being sought are proposals that show advances in, but not limited to, the following:

- Novel Stirling, Brayton or Rankine convertors that can be integrated with one or more 250 watt-thermal General-Purpose Heat Source (GPHS) modules to provide high thermal-to-electric efficiency (>25%), low mass, long life (>10 yrs), and high reliability for planetary spacecraft, landers, and rovers.
- Miniature dynamic power convertors that can be integrated with one or more 1 watt-thermal Radioisotope Heater Units (RHU) to provide long duration electric power for planetary smallsats and distributed instruments.
- Advanced dynamic conversion components including hot-end heat exchangers, cold-end heat exchangers, regenerators/recuperators, alternators, engine controllers, heat pipes, and radiators that improve system performance, reliability, and fault tolerance.

This technology directly aligns with the Science Mission Directorate - Planetary Science Division for space power and energy storage. Investments in more mature technologies through the Radioisotope Power System Program is ongoing. This SBIR subtopic scope provides a lower TRL technology pipeline for advances in this important power capability that improves performance, reliability, and robustness.

Expected TRL for this project is 1 to 4.

NASA has plans to purchase services for delivery of payloads to the Moon through the Commercial Lunar Payload Services (CLPS) contract. Under this subtopic, proposals may include efforts to develop payloads for flight demonstration of relevant technologies in the lunar environment. The CLPS payload accommodations are yet to be precisely defined, however at least for early missions, proposed payloads should not exceed 15 kilograms in mass and not require more than 8 watts of continuous power. Smaller, simpler, and more self-sufficient payloads are more likely to be accommodated. Commercial payload delivery services may begin as early as 2020 and flight opportunities are expected to continue well into the future. In future years it is expected that payloads of higher mass and with higher power requirements might be accommodated. Selection for award under this solicitation will not guarantee selection for a lunar flight opportunity.

References:

Photovoltaic Energy Conversion

- Solar Power Technologies for Future Planetary Science Missions, found at: https://solarsystem.nasa.gov/resources/548/solar-power-technologies-for-future-planetary-science-missions/
- NASA outlines New Lunar Science, Human Exploration Missions, found at: https://www.nasa.gov/feature/nasa-outlines-new-lunar-science-human-exploration-missions
- NASA Science Missions, found at: https://science.nasa.gov/missions-page?field_division_tid=All&field_phase_tid=3951

Dynamic Power Conversion

- https://rps.nasa.gov/about-rps/overview/
- Oriti, Salvatore, "Dynamic Power Convertor Development for Radioisotope Power Systems at NASA Glenn Research Center," AIAA P&E 2018, AIAA 2018-4498.
- Wilson, Scott D., "NASA Low Power Stirling Convertor for Small Landers, Probes, and Rovers Operating in Darkness," AIAA P&E 2018, AIAA 2018-4499.
- Wong, Wayne., "Advanced Stirling Convertor (ASC) Technology Maturation," AIAA P&E 2015, AIAA 2015-3806.