NASA SBIR 2022 Phase I Solicitation

S16.01 Photovoltaic Power Generation and Conversion

Lead Center: GRC

Participating Center(s): JPL

Scope Title

Photovoltaic Energy Conversion

Scope Description

This subtopic is seeking photovoltaic cell and blanket technologies that lead to significant improvements in overall solar array performance for missions in areas of scientific interest including high-intensity, high-temperature (HIHT) such as near the Sun and at the inner planets; low-intensity, high-temperature (LIHT) like in the Venus atmosphere; low-intensity, low-temperature (LILT) at the outer planets, including at distances up to Saturn; and high-radiation environments like that near the inner moons of Jupiter. Additionally sought are solar power systems that can provide high power in compactly stowed volumes for small spacecraft. The subtopic goal is to demonstrate a significant improvement of performance versus state-of-the-art solar cell and array technologies for specific Science Mission locations.

These improvements may be achieved by optimizing the cell technology to operate in a specific environment (HIHT/LIHT/LILT), increasing end of life (EOL) performance, increasing photovoltaic cell efficiency above 35% at 1 AU, development of cells (including encapsulation) for mission-specific environments, and/or decreasing solar cell module/blanket stowed volume. Missions at distances of greater than 1 AU may include an inner-planetary flyby, as such technologies that optimize solar cell string length to account for the changes in power generation are also of interest.

Advances in photovoltaic energy conversion may include but are not limited to, the following: (1) photovoltaic cell and blanket technologies capable of LILT operation applicable to outer planetary (low solar intensity) missions; (2) photovoltaic cell and blanket technologies capable of HIHT operation applicable to inner-planetary missions; (3) photovoltaic cell and blanket technologies that enhance and extend performance in lunar applications including orbital, surface, and transfer; and (4) solar cell and blanket technologies to support missions in high-radiation, LILT environments near Jupiter and its moons.

All proposals relevant to the scope described above would be eligible to be considered for award. For proposals featuring technologies intended for use in planetary science applications, this year a preference will be given to those proposals that would benefit in situ studies of icy ocean worlds, especially low-intensity low-temperature photovoltaic systems.

Expected TRL or TRL Range at completion of the Project

3 to 5
Primary Technology Taxonomy

Level 1

TX 03 Aerospace Power and Energy Storage

Level 2

TX 03.1 Power Generation and Energy Conservation

Desired Deliverables of Phase I and Phase II

- Research
- Analysis
- Prototype
- Hardware

Desired Deliverables Description

Phase I deliverables include detailed reports with proof of concept and key metrics of components tested and verified.

Phase II deliverables include detailed reports with relevant test data along with proof-of-concept hardware and components developed.

State of the Art and Critical Gaps

State-of-the-art (SOA) photovoltaic array technology consists of high-efficiency, multijunction cell technology on thick honeycomb panels and, as of late, lightweight blanket deployable systems. There are very limited demonstrated technologies for HIHT and LILT missions. A current solution for high-radiation intensity involves adding thick cover glass to the cells, which increases the overall system mass.

Significant improvements in overall performance are needed to address the current gaps between the SOA and many mission requirements for photovoltaic cell efficiency >30%, array mass specific power >200 W/kg, decreased stowed volume, long-term operation in radiation environments, high-power arrays, and a wide range of environmental operating conditions.

Little work has been done to optimize solar cell and array technologies for these unique NASA missions, and programs have adapted SOA technologies through engineering methods and acceptance of decreased performance.

Relevance / Science Traceability

These technologies are relevant to any space science, Earth science, planetary surface, or other science mission that requires affordable high-efficiency photovoltaic power production for orbiters, flyby craft, landers, and rovers. Specific requirements can be found in the References, but include many future Science Mission Directorate (SMD) missions. Specific requirements for orbiters and flybys to outer planets include: LILT capability (>38% at 10 AU and <140 °C), radiation tolerance ($6 \times 10^{19}$ MeV e/cm$^2$), high power (>50 kW at 1 AU), low mass (3× lower than the standard operating procedure (SOP)), low volume (3× lower than SOP), long life (>15 years), and high reliability. These technologies are relevant and align with any Space Technology Mission Directorate (STMD) or Human Exploration and Operations Mission Directorate (HEOMD) mission that requires affordable high-efficiency photovoltaic power production.

References

- Solar Power Technologies for Future Planetary Science
  Missions: https://solarsystem.nasa.gov/resources/548/solar-power-technologies-for-future-planetary-science-missions/
- NASA outlines New Lunar Science, Human Exploration
- NASA Science Missions: https://science.nasa.gov/missions-page