NASA SBIR 2020 Phase I Solicitation

S3.03 Energy Storage for Extreme Environments

Lead Center: GRC

Participating Center(s): JPL

Technology Area: TA3 Space Power and Energy Storage

Scope Description

NASA's Planetary Science Division is working to implement a balanced portfolio within the available budget and based on a decadal survey that will continue to make exciting scientific discoveries about our solar system. This balanced suite of missions shows the need for low mass/volume energy storage that can effectively operate in extreme environments for future NASA Science Missions.

Future science missions will require advanced primary and secondary battery systems capable of operating at temperature extremes from -200° C for outer planet missions to 400 to 500° C for Venus missions, and a span of -230° C to +120° C for missions to the Lunar surface. Operational durations of 60 days for Titan and 14 days for the Moon are of interest. Advancements to battery energy storage capabilities that address operation at extreme temperatures combined with high specific energy and energy density (>200 Wh/kg and >200 Wh/l) are of interest in this solicitation.

In addition to batteries, other advanced energy storage/load leveling technologies designed to the above mission requirements, such as mechanical or magnetic energy storage devices, are of interest. These technologies have the potential to minimize the size and mass of future power systems.

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 will vary depending on the particular service provider and mission characteristics. Additional information on the CLPS program and providers can be found at this link: https://www.nasa.gov/content/commercial-lunar-payload-services. CLPS missions will typically carry multiple payloads for multiple customers. Smaller, simpler, and more self-sufficient payloads are more easily accommodated and would be more likely to be considered for a NASA-sponsored flight opportunity. 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 larger and more complex payloads will be accommodated. Selection for award under this solicitation will not guarantee selection for a lunar flight opportunity.

References

- NASA Science:https://science.nasa.gov/
- Solar Electric Propulsion: https://www1.grc.nasa.gov/space/sep/

Expected TRL or TRL range at completion of the project: 3 to 5

Desired Deliverables of Phase II

Prototype

Desired Deliverables Description

Research should be conducted to demonstrate technical feasibility during Phase I and show a path toward a Phase II, and when possible, deliver a demonstration unit for NASA testing at the completion of the Phase II contract. Phase II emphasis should be placed on developing and demonstrating the technology under relevant test conditions. Additionally, a path should be outlined that shows how the technology could be commercialized or further developed into science-worthy systems.

State of the Art and Critical Gaps

State-of the-art primary and rechargeable cells are limited in both capacity and temperature range. Typical primary Li-SO_2 and Li-$SOCl_2$ operate within a max temperature range of -40 to 80 deg C but suffer from capacity loss, especially at low temperatures. At -40 deg C, the cells will provide roughly half the capacity available at room temperature. Similarly, rechargeable Li-ion cells operate within a narrow temperature range of -20 to 40 C and also suffer from capacity loss at lower temperatures. The lower limit of temperature range of rechargeable cells can be extended through the use of low temperature electrolytes, but with limited rate capability and concerns over lithium plating on charge. There is currently a gap that exists for high temperature batteries, primary and rechargeable, that can operate at Venus atmospheric temperatures. This solicitation is aimed at the development of cells that can maintain performance at extreme temperatures so as to minimize or eliminate the need for strict thermal management of the batteries, which adds complexity and mass to the spacecraft.

Relevance / Science Traceability

These batteries are applicable over a broad range of science missions. Low temperature batteries are needed for potential NASA decadal missions to Ocean Worlds (Europa, Enceladus, and Titan) and the Icy Giants (Neptune, Uranus). These batteries are also needed for science missions on the lunar surface. Low temperature batteries developed under this subtopic would enhance these missions and could be potentially enabling if the missions are mass or volume limited. There is also significant interest in a Venus surface mission that will require primary and/or rechargeable batteries that can operate for 60+ days on the surface of Venus. A high temperature battery that can meet these requirements is enabling for this class of missions.