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MISSION CONCEPTS FOR PSRS IN THE SOUTH LUNAR POLE

Abstract

NASA's Artemis program is driving an ambitious return to the Moon, aiming to establish a sustainable presence on the South Lunar Pole. Key infrastructure for this goal includes a habitable lunar base, a satellite communications network known as Lunar Net, and the Lunar Gateway space station, which will provide logistical and communications support for lunar operations.

International collaboration is essential to Artemis, welcoming contributions from agencies such as ESA and JAXA. Additionally, Artemis promotes economic development and innovation opportunities in the lunar sector, opening pathways for both established companies and emerging players in space. Through the Commercial Lunar Payload Services (CLPS) initiative, the U.S. commercial space industry is encouraged to develop lander technologies to deliver payloads for NASA and private entities to the lunar surface.

A sustainable lunar base will depend heavily on In-Situ Resource Utilization (ISRU), especially the extraction and use of water ice from permanently shadowed regions (PSRs) near the lunar poles. These regions, where solar rays strike almost perpendicularly, allow craters to remain in permanent darkness and reach temperatures as low as -163 Celsius, preserving water ice deposits. Remote sensing missions like LOLA and Chandrayaan-1 have identified signatures of ice in these areas through UV and IR albedo measurements. However, current data is limited to about 1 meter in depth and lacks the resolution necessary for detailed resource mapping.

The extreme conditions of PSRs—including temperatures below -163 Celsius and perpetual darkness present substantial challenges. Ice extraction in these areas requires advanced technologies that can overcome power constraints, navigate hazardous terrain, and withstand extreme cold. This study explores the mission requirements, objectives, and technologies needed to develop a feasible concept for a lunar water resource provider. By analyzing current constraints and presenting possible solutions, the report aims to demonstrate a viable approach for supporting lunar operations and advancing humanity's capacity for sustained exploration.