

Return to the Moon (02)
Lunar Surface Outposts and Enabling Technologies (4)

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BENEFITS TO SPACE EXPLORATION FROM IN-SITU RESOURCE UTILIZATION WITH LUNAR
SURFACE AND L1/L2 PROPELLANT REFUELING

Abstract

With the cancellation of the US National Aeronautics and Space Administration (NASA) Constellation Program, NASA is once again reexamining transportation architectures and mission scenarios for human exploration to multiple locations beyond Low Earth Orbit (LEO) including the Moon, Lagrange Points, Near Earth Objects (NEOs), and Mars and its moons. In the last year, several studies inside and outside of NASA have been performed to examine the influence of both heavy lift launch vehicles like the Space Launch System (SLS) and in-space in space refueling resupplied with propellants from Earth on these human mission scenarios. Most of the recent architecture and mission scenario studies have been performed without considering the use of propellants derived from in-situ resources, and if lunar in-situ resource utilization (ISRU) is considered, it is usually as a possible evolution of the architecture at a later date. Numerous past and recent studies aimed at examining how lunar ISRU derived propellants can influence human exploration architectures beyond low Earth orbit (LEO) have shown that i) a return on investment (ROI) in both launch mass and total cost is possible within a reasonable amount of time, ii) that the earlier ISRU derived propellants are included into an architecture, the greater the ROI for mass and cost, and iii) lunar derived propellants enable long term affordable cis-lunar transportation capabilities for sustained human exploration to all destinations of interest while at the same time enabling the commercialization of space. This paper will examine how lunar ISRU can influence both surface and space transportation system designs and architectures with lunar surface and Earth-Moon L1/L2 propellant depots, discuss lunar resources and propellant production possibilities, review the current state of lunar ISRU hardware and system development, and review the opportunities provided by using L1/L2 in the near term to validate the availability and usability of lunar resources. It will provide an overview of the results from several studies that examined the ROI for mass and/or cost for lunar ISRU with surface and L1/L2 propellant refueling.