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Space Resources, the Enabler of the Earth-Moon Ecosphere (5)

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LUNAR IN-SITU RESOURCE UTILIZATION: A ROBUST ANALYSIS

Abstract

Lunar resource utilization is considered as an enabler for an in-space economy and for sustainable space exploration by supplying resources such as volatiles and metals to cis-lunar missions. For analyzing the viability of lunar resource utilization, several parametric models have been proposed, taking various technical and economic factors into consideration. However, these techno-economic analyses face two challenges: the technological alternatives are limited to point designs and the large uncertainties associated with the parameters is not appreciated. In this paper, we conduct a robust analysis of the parametric models for lunar resource utilization missions, taking uncertainties into account and exploring several technological alternatives. We apply a robust optimization approach to analyze the cost-effectiveness of the in-situ processing of propellants and water delivery to cis-lunar space. We demonstrate that given the uncertainties in the parameters, developing technologies such as fast propellant-less propulsion systems and rapid in-situ bootstrapping of mining capacities at the lunar surface could significantly improve the feasibility of the lunar resource utilization missions.