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

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CHARACTERIZATION OF THE COMPETITION BETWEEN REDUCED LAUNCH COST AND DEMAND FOR LUNAR-DERIVED PROPELLANT

Abstract

A large reduction in the cost of space access is commonly thought to be a driver of demand for lunar goods and services. The architecture proposed by SpaceX, currently known as Starship, is frequently cited as being able to provide such a cost reduction. This paper assesses the trade-offs between demand for lunar-mined propellant in cislunar space and reduced cost of launch from Earth. We estimate the cost of mining lunar water and electrolyzing it into propellant by taking estimates of the development, unit, operations, and maintenance costs and amortizing them over a decade to produce a cost per kilogram of lunar propellant as a function of demand. We take a similar approach for modeling the costs of Starship missions to and from the lunar surface. Additionally, we model the orbital maneuvers of Starship to estimate the number of on-orbit refueling missions required for various missions, with and without lunar-derived propellant. Finally, using estimates of demand for government space exploration and private lunar tourism, we estimate costs for starship crew and cargo missions and lunar propellant production that meet the demand. Using these costs and demands, we quantitatively characterize the scenarios in which Starship increases demand for space resources. Similarly, we characterize scenarios in which Starship delivers terrestrially-launched propellant to customers in cislunar space more cheaply than it could be manufactured and delivered from the surface of the moon.