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EVALUATION OF THE ECONOMICS AROUND SPACE RESOURCE EXTRACTION AND IN-SITU RESOURCE UTILIZATION (ISRU)

Abstract

This paper is an expansion on a prior publication from this author, *Changing the ISRU Paradigm from Sustainability to Economic Tool*, with a focus on broadening the discussion to intersect with broader economic frameworks. The analysis herein delves into the fundamental cost of goods based on the sum of three sources: extraction, manufacturing/refining, and logistics. This paper considers the extraction of resources for export, not just In Situ Resource Utilization (ISRU). Ambitions to extract precious metals from asteroids and plans to export ice resources from the Moon parallel the era of colonization and current export of resources like oil and wheat, which are helpful foundations for understanding the potential for space resource extraction. This paper proposes that extractable space resources should be expanded to include the extraction and export of light, in the form of energy and telecommunications, as these are the first and most profitable resources available.

A key observation is the unique advantage posed by photons in space operations, which effectively ignore planetary gravity wells, thus dramatically reducing logistical costs. This insight is foundational to understanding the economic viability of space resource extraction and ISRU on a larger scale.

Currently telecommunication satellites represent one of the purest examples of ISRU in the global economy as well as most of the space sector's revenue. They convert local sunlight into value through the processing, sending, and receiving of encoded photon steams. A central expansion on this discussion is the concept of Space Solar Power (SSP), reframed here as a form of space resource extraction for export. The declining costs of critical SSP subsystems underscore its increasing economic, geopolitical, and environmental viability terrestrially. Leveraging advancements in launch technology, digital wave forming, and solar photovoltaics, SSP (which has been technically viable for decades) presents a compelling economic opportunity to harvest solar energy in space and export it as a novel power source. This argument is even stronger for other surfaces, like the Moon, where there are no clear alternatives for stable power generation or existing local infrastructure.

This paper advocates for a paradigm shift in space resource discussions, emphasizing the economic potential of moving photons as both power and information as a template for future extraction and export of mass. By providing clear economic metrics and frameworks, this paper aims to inform policy discussions and spark further research into managing the revenue streams generated from space resource utilization.