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Development of the Moon-Earth economy – 2030-2050

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In this paper I will present scenarios of lunar industrial development to 2050 and corresponding development of markets for lunar resources in Earth orbits, cislunar space, the lunar surface, as well as the likely emergence of industrial development in Mars orbits based on use of lunar resources. I will also examine actions needed in the 2021-2030 timeframe to make this possible.

Given that targets for launch to LEO from Earth in the range of $100 to $200/ kg. can be achieved before 2040 the Moon can emerge as the low-cost source of materials for industrial and commercial development in the Earth-Moon system and beyond. Key assumptions that I will examined include the following:

- Structures in Earth orbits and cislunar space will be assembled in orbit from components manufactured in space.
- Space tourism with large-scale space resorts in low Earth orbits will give way to space settlements housing thousands and more as mortgage financing is developed to finance their development.
- The Moon will emerge as the low-cost site for materials for space manufacturing. Many important materials are on or near the surface and there is high probability of concentrations of high value materials being discovered in accessible locations including potentially the Aitken Basin anomaly [1}. , and the vacuum and fractional gravity of the Moon promises launch costs from the Moon to Earth orbits that are a fraction of launch from Earth.
- Lunar materials are likely to emerge as a primary source for industrial and commercial developments in Mars orbits. The delta-v of shipment to Mars orbit from the lunar surface is less than launch from Mars [1]. Industrial development in Mars orbit using lunar materials can lower costs and improve effectiveness of operations on Mars.
- It will become increasingly urgent to limit launch of spacecraft to LEO from Earth as congestion from satellite mega constellations increases and suborbital intercontinental transportation takes off following the model proposed by Elon Musk.
- Climate change is a threat to all countries and urgent action is called for to limit or eliminate large scale resource extraction on Earth, as well as to limit launches through the atmosphere. This factor will speed lunar industrial development and potentially open opportunities for some lunar derived materials to compete in terrestrial markets.
- A rules-based order agreed to by all states involved in outer space development will emerge by 2030. Billionaires can speed up development but international cooperation and agreement on governance policies is necessary to assure self-sustaining lunar industrial development.

Notes

[1] An excellent overview of lunar materials that also includes discussion of processing options is Ian A. Crawford, "Lunar resources: A review", Progress in Physical Geography, 2015, Vol. 39(2) 137–167, retrieved from http://www.homepages.ucl.ac.uk/~ucfbiac/Lunar_resources_review_published.pdf . Pg. 149 summarizes findings on the Aitken Basin anomaly suggesting that a large metallic asteroid approximately 110 meters across may be buried there. The Psyche 16 metallic asteroid that has drawn media attention is 200 meters - 16 Psyche - Wikipedia

[2]https://space.stackexchange.com/questions/2046/delta-v-chart-mathematics