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SPACE EXPLORATION SYMPOSIUM (A3)
Moon Exploration – Part 2 (2B)

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ON THE EVOLUTION OF ENERGY SUPPLY FOR FUTURE HABITATS ON THE MOON – AN EXAMPLE BASED ON LUNAR OXYGEN PRODUCTION

Abstract

In order to significantly reduce cost while increasing operational flexibility of space endeavours, sustainable exploration and exploitation activities are crucial. One building block for long-term scenarios is a lunar outpost serving amongst others as a basis for further travels to Mars and beyond. In this case, in-situ resource utilization (ISRU) would decrease the transport of additional resources from Earth and hence raises the level of autonomy on the Moon. The production of oxygen – for breathing and especially for propellant – out of Regolith, the dust layer on the lunar surface, is a core element for the set-up of a remote launch site and Moon base. Moreover, sufficient on-site energy supply for such a mission is essential as well. The Institute of Space Systems of the German Aerospace Center (DLR) has developed a small demonstration facility in order to perform research on oxygen extraction out of lunar soil (simulants). Meeting the different energy demands and serving adequate power levels for the various process steps are main design drivers. Many studies propose the use of parabolic dishes for concentrating solar rays to generate the required energy for the main chemical reactions, but for other tasks, different energy sources and combinations might be much more efficient. The DLR Advanced Study Group (ASG) has analysed a potential evolution of required and deliverable amounts of energy, considering (a) the increasing demands, (b) technological options, (c) space law aspects and (d) lunar outpost scalability over time. The latter takes into account current international roadmaps along with additional assumptions. Concretely, four different scenarios have been defined, including a demonstration mission, temporarily and permanent manned outposts as well as a self-supporting base. Focusing on a lunar oxygen production plant as the main driver, the study looks at the overall growth, e.g. for science-, ISRU-, power- and accommodation units, and how this could lead to changes of energy source combinations. Regarding the extraction, Ilmenite reduction with hydrogen has been selected since it is one of the most proven processes. Incorporating previous lunar studies as well as current technologies for energy generation, storage and supply, this work describes relevant evolutionary steps of a future settlement on the Moon. It derives major technical and strategic drivers for suitable combinations of power units. Furthermore it proposes an evolving supply scenario for a growing lunar oxygen production plant and provides an overview of the limitations with respect to legal and regulatory issues.