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Moon Exploration – Part 3 (2C)

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DESIGN AND ASSESSMENT OF A SYSTEM FOR MOON ENERGY STORAGE AND GENERATION

Abstract

The Moon, largely considered as the next stepstone on the path of extending mankind's reach beyond the ISS, is the focus of many national and international campaigns for manned exploration of the solar system. To enable and safeguard the survival of habitation and technological assets on the surface (facing nights up to 14 Earth days and temperatures between 100 and 400 K), robust surface system technologies, taking advantage of in-situ resources, need to be developed. One such key system is the object of a research project led by Sonaca Space GmbH (with BlueThink S.p.A., the German Aerospace Center - DLR and OHB System AG), financed by ESA, with the objective to assess and design a system to efficiently store thermal energy, and utilize it for the production of electricity to support surface operations. Embracing an ISRU approach, the native regolith, specifically processed to improve thermal properties, is identified as heat storage medium. This energy can be delivered either as heat or transformed in electricity through a heat engine. The architecture of the system is defined by first assessing suitable technologies for each building block of the system separately, and then analysed altogether in a complex thermal system parameterized design. Since possible technologies for each building block may not allow a completely free selection of the other blocks (due to unavoidable dependencies or simply not optimal performances of the technology chain), three different configurations have been in a first place identified and screened for the selection of a baseline for the system. The finally selected and optimized system described in this

paper incorporates a solar collector as a mean to collect solar energy and through a novel heat transfer device (optical waveguides) to transport it for storage in the processed regolith. Properly identified high capabilities heat transfer devices (such as liquid metal loop heat pipes) are used to transfer the heat to the heat engine for energy conversion (Stirling engine), followed by the cold side of the system composed mainly by a radiator for residual heat disposal. The system's performances and sizing were evaluated for different users, which resulted in promising estimations, such as the provision of electrical energy for the night operations survival of a 115 W lander with a thermal mass slightly larger than 2.5 m. To support the system design, a demonstrator is designed in order to verify the system assumptions.