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IAF SPACE POWER SYMPOSIUM (C3)
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STAND-ALONE POWER SYSTEM (SAPS) DESIGN FOR A LUNAR HABITAT: THE FLEXHAB CASE STUDY

Abstract

One of the biggest challenges in future long duration deep space missions is the generation, storage and distribution of electrical power. Planetary exploration scenarios with astronauts will need to utilise safe, reliable, and easily maintainable systems. The present work addresses the challenges inherent to the development of an electrical power system for a lunar habitat. In the framework of the Moon Village initiative, the European Space Agency (ESA), together with commercial partners, is building two analogue facilities at the European Astronaut Centre (EAC) in Cologne, Germany: LUNA and FlexHab. FlexHab, as an analogue for a habitation module, will be powered via a bespoke Stand Alone Power System (SAPS). This renewable energy system is composed of photovoltaic arrays, batteries, electrolyser, fuel cell, and gas storage tanks. Due to the intrinsic differences between the terrestrial and lunar environment in terms of illumination cycles, the SAPS also has the possibility to augment the energy demand of the FlexHab with a shaped power generation profile from the grid. This feature will allow for an accurate representation of any lunar illumination status, regardless of the real environment conditions present at the site in Cologne. A significant aim of this system is to provide real data onto how those peculiar energy systems can operate on the Moon surface at a system level, thus helping to address aspects that might be overlooked as transient phases. Trade-off studies for optimizing the design and the actual operation of the SAPS have been carried out using numerical simulations. A lumped parameters model has been developed using MATLAB® to estimate the energy system performances. The results obtained in this paper show how the SAPS is able to operate both in actual terrestrial and simulated lunar conditions, where the grid is used to balance the electrical power.