A SOLAR POWER INFRASTRUCTURE AROUND SHACKLETON CRATER.

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Introduction: A solar power infrastructure around Shackleton Crater (SC), at the South Pole of the Moon, would leverage the favorable conditions of sunlight in the area [1] and power multiple assets simultaneously and without interruptions. The concept has evolved from a study funded by the NASA Innovative Advanced Concept (NIAC) Program, in which the main idea was to put heliostat reflectors on the rim of SC to redirect sunlight into areas of darkness inside or outside the crater, creating *oases of energy*.

Placement of the reflectors: An optimization program is run to determine the best placement in surface coordinates and in height above ground, for a given number of reflectors. The reflectors are to be placed such that they are complementary in function, and at least one reflector sees the sun at least in part above the horizon, and also has direct line of sight to the region where solar energy needs to be reflected. Without loss of generality the study focuses on reflecting the solar power directly; however conversion and transmission by microwave or laser is also considered. The location and corresponding oasis map for three reflectors placed 300 meters above ground level are shown in Figure 1 [2].

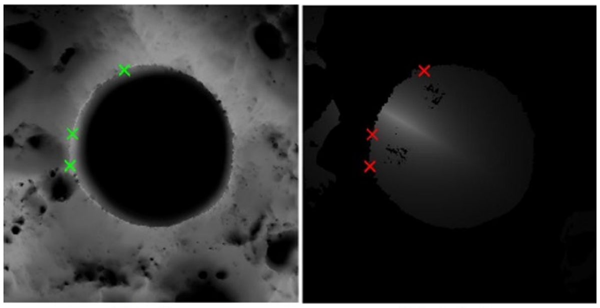
(a)Locations (b)Oasis Region

Figure 1. Locations of set of three reflectors and oasis region receiving 99% annual sunlight.

The annual illumination percentage as a function of the height of the reflectors above the ground, on the crater rim, is shown in Figure 2.

Sizing reflectors for obtaining LH_2 /LO_2 propellant: An architecture for sustainable human exploration of Mars enabled by water from the lunar poles was presented in [3]. The architecture would be enabled by 7.5 metric tons (t) of propellant per day, hence 10 t of ISRU extracted water.

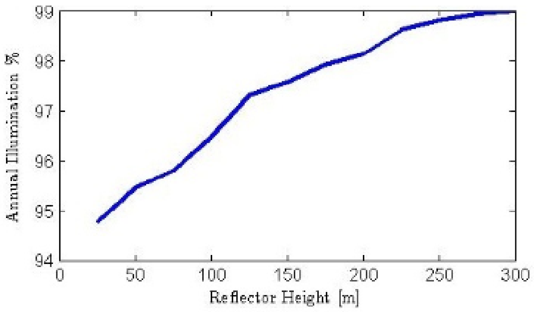

Figure 2. Annual illumination percentage vs height of reflectors placed at locations in Figure 1.

An estimated ~0.6 MW thermal power (assuming 10% water in regolith), and, in a lossless transmission, ~0.6 MW solar power needs to be reflected from the rim. About 2 MW electric power, which may add to 6 MW of solar power reflected, would be needed for obtaining LH_2 and LO_2.

Implications for a lunar economy: The solar power could be reflected or concerted and then transmitted via laser or microwave; tradeoffs depend on distance and end use. Final destination could be reached via multi-hop relays, in a network that could extend tens of kilometers from the south pole (or north pole). Such an energy infrastructure would be an enabler for lowering cost of operations and stimulating a lunar economy. The energy infrastructure would to a large extent eliminate the extreme environment barrier: cheaper solar-powered robotic systems built for Earth-like conditions can be sent in long duration missions. It would modify the business practice as missions will only pay for thermal and energy after confirmed safe arrival landing and money will be paid in increments as opposed to upfront. Such an infrastructure could change the way missions are designed and operated, lower the barriers of entry for new participants in lunar exploration and economy, would allow long term missions in regions without natural solar illumination.

References: [1] Bussey, D.B.J and Spudis P. D, *A Wet vs. Dry Moon: Exploring Volatile Reservoirs and Implications for the Evolution of the Moon and Future Exploration (2011), Abstract #6038* [2] Henrickson J.V. and Stoica A (2017) *IEEE SMC Conf,* 2006–2011. [3] Wilcox *et al* (2017) *IEEE Aerospace Conf.*