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Systems and Infrastructures to Implement Sustainable Space Development and Settlement - Systems (2A)

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HOW MUCH SOLAR POWER CAN BE GENERATED AT THE "PEAKS OF ETERNAL LIGHT" AT THE LUNAR SOUTH POLE?

Abstract

To allow sustained, affordable and highly effective operations on the Moon requires a large amount of power. Nuclear power and solar power are the only known options. It is important to know whether nuclear power is required, and so the maximum obtainable solar power. The highly illuminated regions near the lunar South pole (the so-called "Peaks of Eternal Light") have been assumed by many authors as a source of solar power for support of human bases and for mining the water and other volatiles in the nearby permanently dark regions. As mining is a power-intensive activity, possibly in the Gigawatts range, it is useful to estimate the maximum solar power that could be generated at these highly illuminated regions. The illumination, and so power available, depends sensitively on the elevation of the solar panels would have above local ground level. We have used average illumination maps for a range of heights above the local topography from heights of 2 m to 2 km to determine the total power available as a function of time of lunar day. Overshadowing of highly illuminated areas by towers of solar panels placed in sunward locations (at a given time of day) limits the total power to much smaller values than the total highly illuminated area would suggest. We find that for near-term realizable towers (up to 20 m), the upper limit to the time-averaged power available is ≈ 55 MW at $> 70\%$ illumination, and ≈ 6 MW at $> 90\%$ illumination. This is likely adequate for an initial human base. For the more distant future, when mining is a major enterprise on the Moon, a maximum time-averaged power of order 21,000 MW at $> 70\%$ illumination could be realizable for towers up to 2 km in height, dropping to ≈ 5300 MW at 90% illumination. Towers 1 km high provide about a factor 2.7 times less power. The variation in generated power with lunar time of day ranges from a factor of as little as 1.1 to up to ≈ 3.