Paper ID: 54442
oral

17th IAA SYMPOSIUM ON BUILDING BLOCKS FOR FUTURE SPACE EXPLORATION AND DEVELOPMENT (D3)
Systems and Infrastructures to Implement Sustainable Space Development and Settlement - Systems (2A)

Author: Dr. Rochelle Mellish
United States

SOLAR ELECTRIC GRID DESIGN FOR A SIMPLE MOON BASE

Abstract

Over the past several decades there has been growing interest in the founding of a lunar colony. Not only would a lunar base be a convenient extraterrestrial testbed for prolonged human habitation in space, but it could also serve as a launch pad for future trips to Mars. Despite the many advantages of developing a moon colony, infrastructure development is non-trivial, with a salient aspect of the infrastructure being the power grid. Solar-powered grid designs are of particular interest because of the low-cost associated with renewable energy, and the prohibitive environmental, monetary, and developmental costs associated with fossil fuels.

Using the Electric Power System (EPS) of the International Space Station (ISS) as a roadmap, a solar-powered electric grid is designed for a colony located at the moon's North Pole. There, constant sunlight is guaranteed when the moon is not occluded by the earth. The solar powered grid design process is comprised of solar panel and battery bank sizing, with the first step being loads characterization. The electric grid is comprised of a small set of loads, including: a large lighting system that uses 35,000 W, a central A/C system that uses 3,500 W, three computers that collectively use 750 W, an electric oven that uses 2000 W, and a refrigerator that uses 1,200 W. During the 354-hour period that the moon is in sunlight, the loads are powered by the solar arrays and the batteries are charged in preparation for eclipse.

When the moon is occluded from the sun by the earth, the batteries provide electrical energy to the colony. In eclipse, the fan system that was at work during the lunar day is swapped for a heating system, which is stated to use 26,500 W of energy. Most of the other loads' usage remains the same, except for the lighting system, whose daily usage is increased.

The sizing process revealed that approximately 1,271 square meters of solar panels connected in series and batteries that had 1,184,300 Amp-hour capacity would be needed to power the moon base continuously. To achieve the voltage and amp-hour requirement, it was necessary to use 1139 1040-Amp-hour batteries connected in parallel. The conclusions of this work show that with a robust budget and the capability to launch multiple electrical components into space, a moon base situated at or near the moon's North Pole with common components and appliances is a feasible proposition.