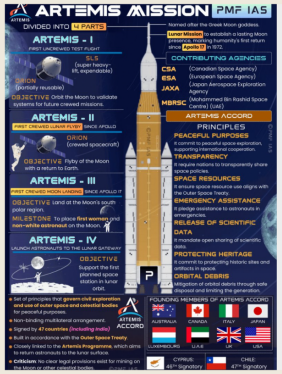
Lunar PRO- Lunar Unified Network for Assessing Resource-driven Power Requirements and Operations

Daria Opekunova, PhD Candidate, Colorado School of Mines
Advisor: Dr. George Sowers

With space and lunar missions increasing globally each year, sustainable lunar operations will require substantial power infrastructure, yet current studies largely overlook the economics of lunar energy development—a gap this model addresses by analyzing power demands from planned missions to assess economic viability.

01. Introduction

This research develops comprehensive power demand models based on planned government and private missions across various lunar locations, establishing the foundation for economic frameworks that assess the financial sustainability of lunar power infrastructure investments



Sustainable Lunar Presence Will Need Power

"With NASA's Artemis campaign, we are exploring the Moon for scientific discovery, technology advancement, and to learn how to live and work on another world as we prepare for human missions to Mars.
We will collaborate with commercial and international partners and establish the first long-term presence on the Moon.
NASA will land the first woman, first person of color, and first international partner astronaut on the Moon using innovative technologies to explore more of the lunar surface than ever before".

-NASA

02. Objective

Primary Objectives:

- Quantify power demand profiles for diverse lunar operations
- Develop economic viability models for lunar power infrastructure technologies
- Assess scalability and cost-effectiveness of different power systems
- Map location-specific power requirements

Secondary Objectives:

- Evaluate infrastructure investment strategies for sustainable lunar energy development
- Identify optimal power system configurations for different lunar locations and operational demands
- Establish economic frameworks for public-private partnerships in lunar power infrastructure

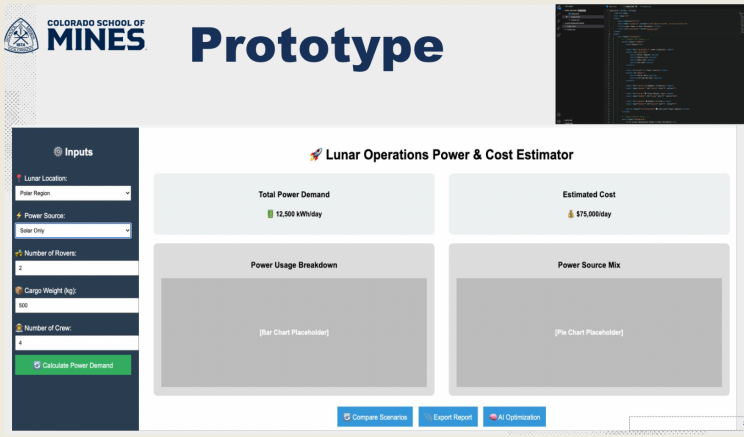
03. Methodology

A comprehensive methodology integrates mission analysis, economic modeling, and geospatial assessment to quantify lunar power demands. Planned government and private missions are systematically analyzed to establish power requirement profiles across lunar regions. Economic frameworks evaluate technology cost-effectiveness and scalability, while geospatial analysis maps location-specific power needs considering environmental constraints and resource availability.

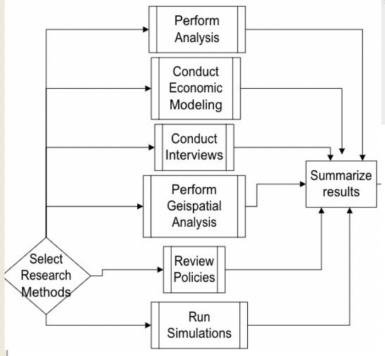
- **Interviews**
- **Surveys**
- **Comparison studies**
- **Experiments**

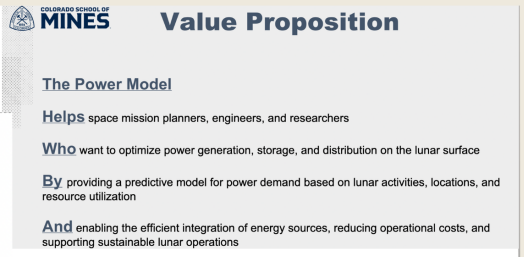
04. Results/Findings

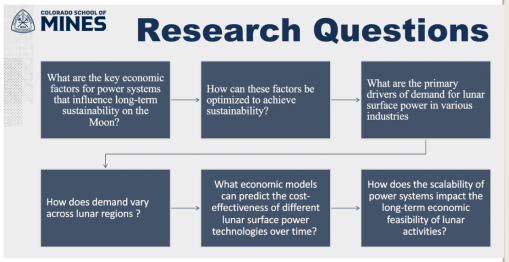
Power needs have been characterized based on operational requirements and lunar site locations, providing quantified demand profiles for various mission scenarios. Future work will integrate these demand signals into economic frameworks to assess the long-term viability and sustainability of lunar energy infrastructure investments



05. Analysis







06. Conclusion

Power demand modeling across planned lunar missions reveals location and technology-dependent economic trade-offs critical for sustainable lunar development. Solar power systems offer cost advantages for moderate-demand equatorial operations, while nuclear technologies prove essential for high-power polar missions. Strategic infrastructure coordination can significantly reduce operational costs, emphasizing the need for integrated economic planning in lunar power system deployment. This research provides frameworks for optimizing lunar energy investments and supporting long-term human presence on the Moon