LUNAR-PRO: LUNAR UNIFIED NETWORK FOR ASSESSING RESOURCE-DRIVEN POWER REQUIREMENTS AND OPERATIONS.

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Introduction: A sustained human and robotic presence on the Moon requires a reliable and scalable energy infrastructure. This research focuses on developing LUNAR-PRO (Lunar Unified Network for Assessing Resource-driven Power Requirements and Operations)—a predictive modeling framework designed to assess power demand, system scalability, and economic viability for lunar surface energy solutions.

LUNAR-PRO integrates power generation, storage, and distribution models tailored for milestone-based activities in the lunar environment. The framework considers solar power, nuclear fission, and alternative energy sources while incorporating energy storage solutions and microgrid configurations for various ISRU activities in different locations.

The model architecture consists of:

1. **Power Generation Module:** Evaluates solar, nuclear, and hybrid system efficiencies based on location, operational constraints, and energy capture potential.
2. **Storage & Distribution Module:** Analyzes the role of stationary battery banks, regenerative fuel cells, and redox flow batteries in sustaining operations during lunar nights.
3. **Operations Module:** analyzes planned ISRU activities from private and public companies and governments from the energy requirements angle.
4. **Economic Viability & Scalability Module:** This module incorporates cost projections, demand forecasting, and market analysis to determine sustainable business models for lunar power deployment.

Projected Outcomes:

- Power Demand Predictions: The model will generate location-based power requirement estimates for critical lunar activities such as habitat operations, ISRU mining, and scientific stations.
- Scalability Analysis: Evaluate how energy infrastructures can scale from early Artemis missions to permanent lunar bases, including autonomous energy redistribution strategies.
- Economic Feasibility: This section provides a cost-benefit analysis of power architectures based on lunar market dynamics, infrastructure investment scenarios, and in-situ resource utilization (ISRU) potential.

LUNAR-PRO aims to provide a data-driven approach for planning lunar surface power systems. The research will contribute to NASA's Artemis objectives, commercial lunar missions, and international development initiatives. Since this research is in its early stages, the overall architecture of the model, objectives, and methodology will be presented.