LUNERGY: A PROPOSED LUNAR UTILITY SCALABLE TO ONE MEGAWATT. J. Goldblatt,[1] G. Griffitt[1,3], S. Kamal[1], R. Royall[1], C. Smith[2] and J. Yandle[1], [1] Colorado School of Mines, Center for Space Resources, 1310 Maple Street, GRL 234, Golden, CO 80401; jacob_goldblatt@mines.edu; Gregory_griffitt@mines.edu; shukrullah_kamal@mines.edu; rroyal@mines.edu; Jonathan_yandle@mines.edu). [2]14436 NW Holly Rd., Seabeck, WA 98380, johnsmith@mines.edu; 1310 Maple Street, GRL 234, Golden, CO 80401, gregory_griffitt@mines.edu (presenting authors)

Introduction: The proposed Lunergy one-megawatt electric (MWe) utility uses a modular hybrid architecture combining nuclear fission and solar power with centralized energy storage, microwave power beaming, and high voltage direct current (HVDC) distribution.

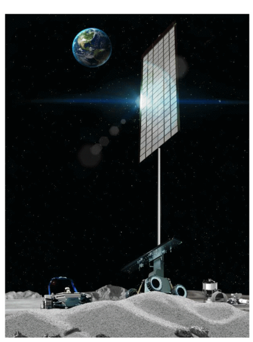
Operating Environment: The Lunergy system is designed for lunar South Pole conditions to support NASA Artemis and commercial users requiring continuous power throughout the lunar day and night. Customers may include exploration, *in-situ* industrial and mining operations, research, habitation, vehicle recharging, medical, educational or other commercial or government facilities

Service Model: Lunergy is designed to deliver power as a service (PaaS) with guaranteed availability.[1] Customers can "plug" into Lunergy's grid instead of fielding their own power systems.

Growth Path: Phase 1 of Lunergy will support early Artemis or Commercial Lunar Payload Services (CLPS) users with electricity delivery up to 100 kWe. Phase 2 would provide ~200 kWe, with continuous expansion continuing. System architecture in modular blocks will scale towards megawatt-class power and broader industrial development.

Core Technical Architecture:

Hybrid Generation: Baseload will be provided by scalable 100 kWe or larger fission surface power (FSP) nodes.[2] Vertical Solar Array Technology (VAST) [3] will be fielded on high-illumination ridges to add supplemental power and resilience during early phases.



Power Backbone: All power source output is conditioned onto a site-wide HVDC backbone of at least 10 kVe for efficient, low-loss transmission and straightforward DC source and sink integration.

Resilient Energy Storage: A centralized Regenerative Fuel Cell (RFC) and Li-ion buffer, completed by distributed node 15-20 kWe batteries, shifts daytime excess power production to night operations, riding out transient power distribution and supporting "black start." [4]

Hybrid Distribution: The distribution system consists of 1) Microwave Power Transmission (MWPT): microwave phased-array transmitters beaming power to line-of-sight (LOS) rectenna receivers which supply to 30 kWe DC power to customer rectenna pads; 2) Fixed Nodes: supplied by possibly buried HVDC cabling to deliver bulk power from power supply to storage, [5] and from rectennas to stationary customer sites and grid nodes; 3) Universal Modular Interface Converters (UMIC) convert RF to DC from and to Lunergy nodes.

Subsystem Descriptions:

Power Generation Subsystem: FSP plus polar ridge VSAT solar arrays export HVDC to Lunergy power transformer and conditioning subsystem

Power Transformation and Conditioning Subsystem: front-end conversion and protection for reactor, solar, and rectennas converts power to ≥ 10 kVe HVDC.

Energy Storage Subsystem: central hub is RFC + Li-ion hybrid with distributed 15-20 kWe battery nodes for eclipse continuity and for black-start, fault recovery and power grid integration

Energy Transmission Subsystem: MWPT ("Power Beaming") using phased array transmitters [6] at 5.8 GHz [7] beaming conditioned power to rectenna pads (≥ 30 kWe each) with backup cabling to customer sites

HVDC Backbone and Converter Stations: 10 kVe aluminum backbone with solid-state breakers; dc to dc stations step voltage for zones and feeds subsystems from power generation and storage nodes

Customer Distribution Subsystem: Local HVDC nodes with solid-state protection and standardized electrical grid ties. (Customers provide local connection hardware for distribution around local campuses)

Command, Control and Safety: Command Control (C^2), electric grid management and Fault Detection, Isolation and Recovery (FDIR) regulate all Lunergy subsystems.[8]

Support and Maintenance: Periodic and responsive maintenance, spares and procedures using a "3 Laws"-compliant [9] AI-enabled semi-autonomous robotic workforce. The robotic workforce will provide on-site inspection and repair with C^2 via Earth-based teleoperations to maximize system availability (A_0)

References:

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