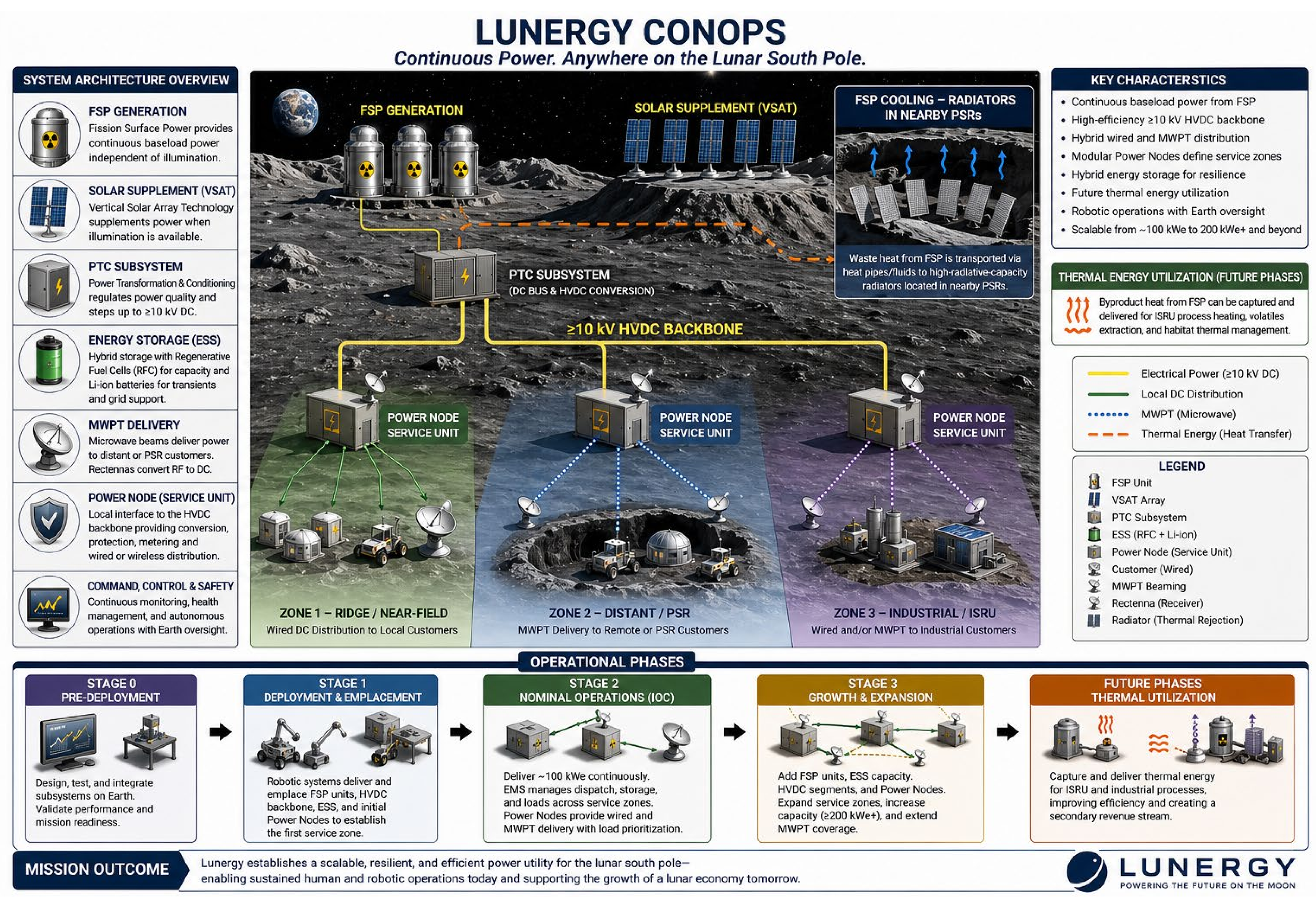
LUNERGY: A Proposed Lunar Utility Scalable to One Megawatt (MWe)

John C Smith, Jr., PE, MSCE[1]; Greg Griffitt; Jacob Goldblatt; Shukrullah Kamal, Vincent Mirolli; Riley Royall; Jonathan Yandle; Master's Degree graduates, Colorado School of Mines Space Resources Department

[1]presenting and corresponding author, johnsmith@mines.edu, (904)716-1214

INTRODUCTION: Lunergy is a proposed utility to deliver continuous, utility-grade power (100 kWe, Phase 1) using Fission Surface Power (FSP), a10 kV DC (HVDC) backbone and Microwave Power Transmission(MWPT) to serve both ridge and permanently shadowed region (PSR)customers.



Siting Rationale: Shackleton Crater Rim

1) The first consideration to drive siting at Shackleton is the solar resource. Literature and topology studies identify persistent illumination zones on the Shackleton rim where average annual illumination exceeds 80% over multiyear cycles, with maximum continuous shadow intervals on the order of three to five days rather than the equatorial 14.5-day lunar night (Nasa LOLA, 2023).

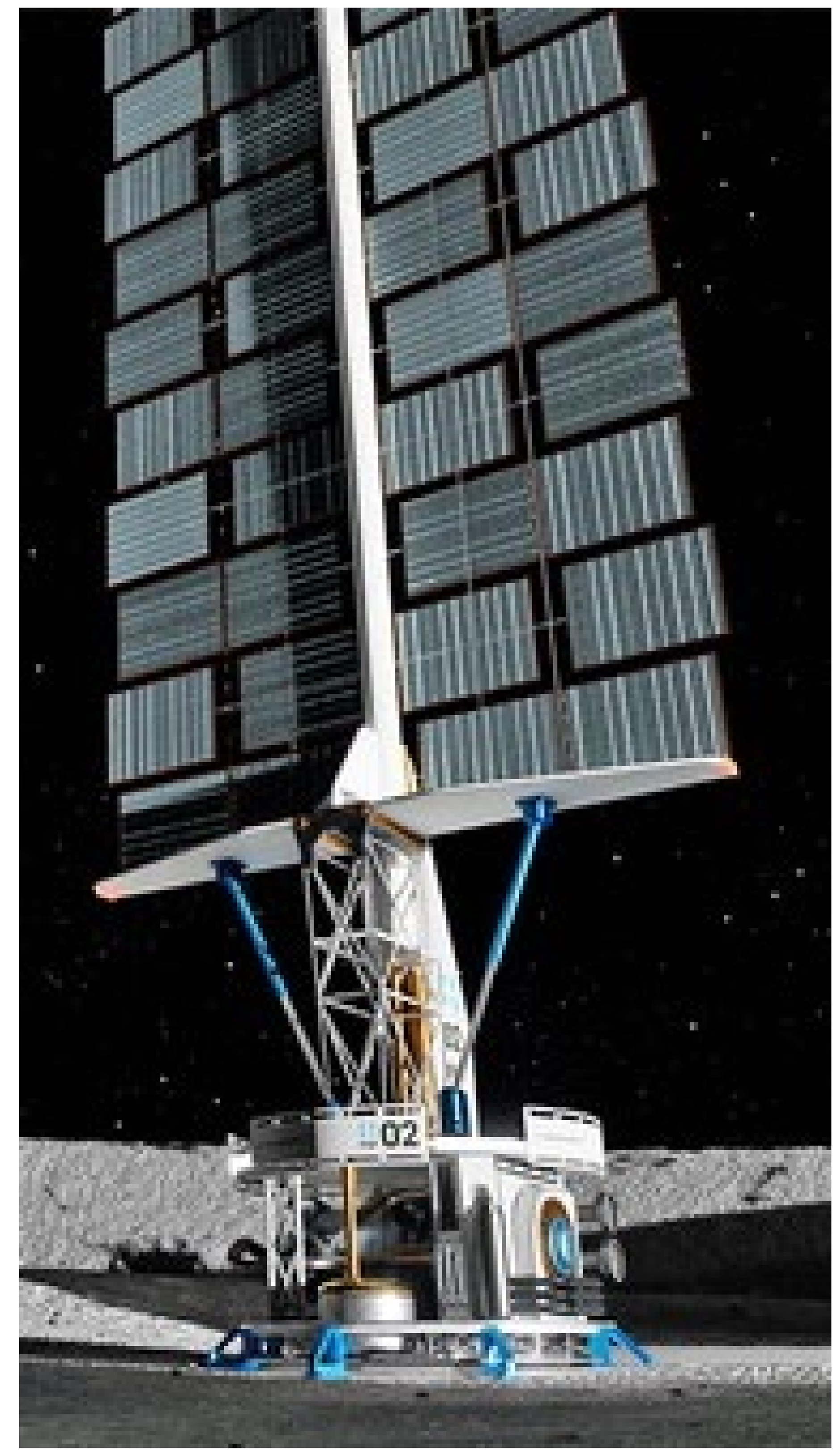
2) The second is the In-Situ Resource Utilization (ISRU) feedstock. The permanently shadowed regions at the Shackleton interior contain confirmed water-ice deposits, providing the feedstock for the propellant production, life support, and industrial chemistry that drive Tier 1 and Tier 2 demand. ISRU operations cannot be relocated to the equator; they must be sited where their feedstock exists.

3) The third is the demand co-location. The Artemis Base Camp, the published manifests of NASA Commercial Lunar Payload Services (CLPS) class commercial landers, the SpaceX Moon Base Alpha plan, and the published trajectories of all major commercial lunar proposals concentrate at the lunar south pole. Co-locating Lunergy with this concentrated demand minimizes both transmission loss and customer integration cost. The HVDC backbone is sized for a 5 km Phase 1 service radius, extensible to 100 km in Phase 2, with MWPT extending service into permanently shadowed regions and to mobile assets without additional buried cable.

Phased Deployment Schedule

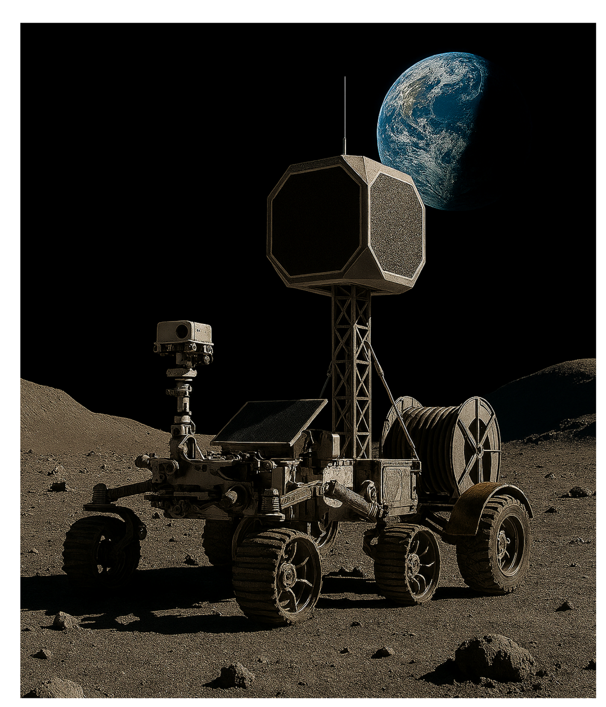
Phase	Years	Capacity	Tariff
1 — Early habitat & pilot ISRU	1–4	1 block, 200 kWe	$350/kWh
2 — Scaling ISRU & mining	5–9	6 blocks, ~1.1 MWe	$175/kWh
3 — Industrial build-out (Gen 2)	10–16	11 blocks, ~2.2 MWe	100–75/kWh
4 — Mature operations (Gen 3)	17–30	20 blocks, ~4.7+ MWe	60–50/kWh

Center *for* Space Resources



Lockheed Martin concept for a lunar nuclear reactor (100 kWe?) [4][5]

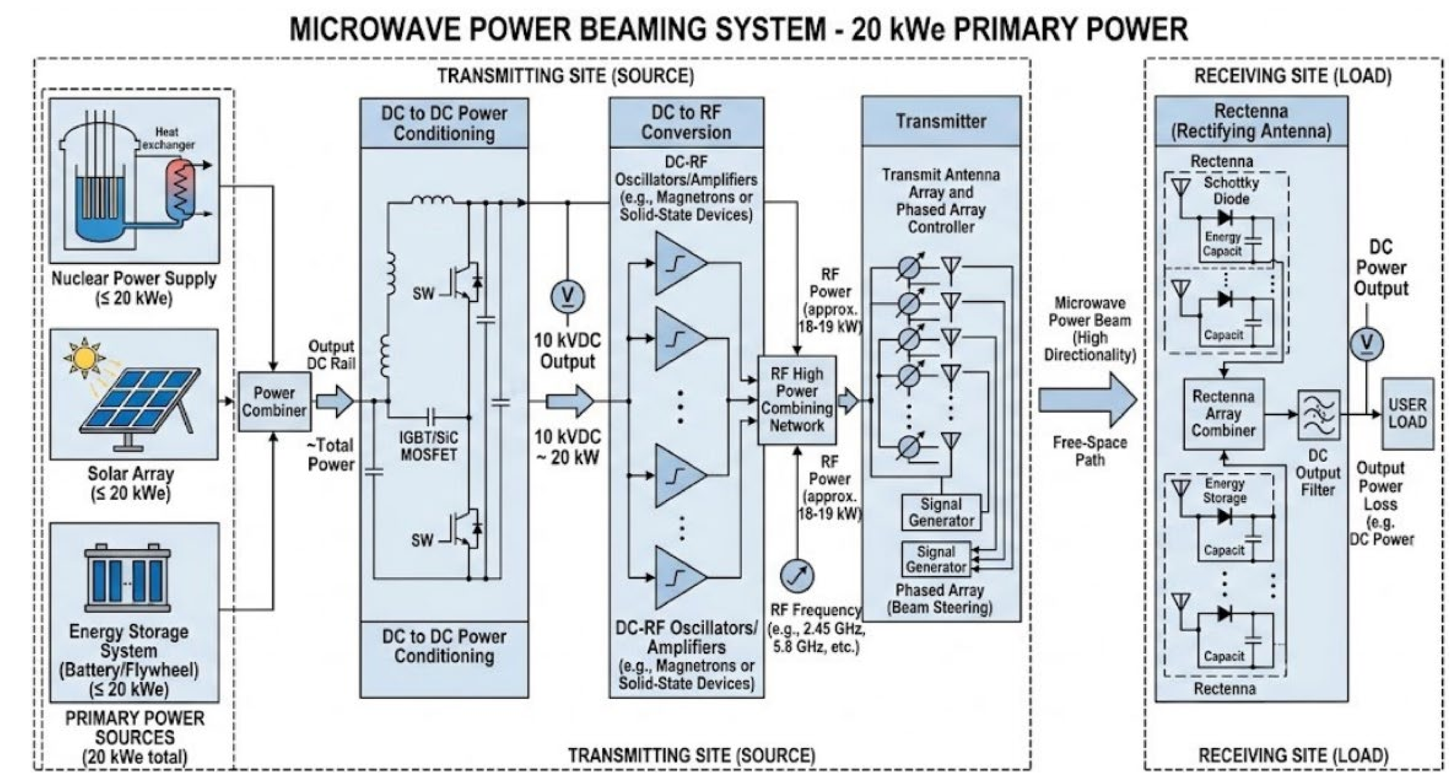
This proposal has a mass less than 15 MT. Note that the last US nuclear reactor flown in space was SP 10A, in 1965



Proposed microwave wireless transmission device for power beaming to remote sites [3]

Primary Power Generation DETs

TEST NAME	TEST OBJECTIVE	TEST ARTICLE	POTENTIAL FACILITIES
SYSTEM: MWWPT POWER SUPPLY			
LR-1 Lunar Power Supply Production	Measure Voltage and Current produced, under simulated lunar vacuum, temperatures and dust	Assume LR-1 reactor is 20 kWe follow on from SR-1 20 kWe (Kratsios 2026), (NASA 1 March 2026)	PLANET (Planetary Lunar and Asteroid Natural Environments Testbed) scheduled for customer access, mid-2024: Testing in these can raise TRL (Hayward, 2023)
TRANSMITTER SUBSYSTEM			
Phased Array Aperture Transmission	Measure beam node structure, transmission distance dispersion, and power transmitted in earth environment	Phased Array Aperture	Anechoic chambers measures beam forming and dispersion; IEEE standards include ANSI/IEEE Std 149-1979: IEEE Standard Test Procedures for Antennas (IEEE 2022)
Phased Array Transmitter effective range	measure transmission	Phased Array Transmitter	Earth-based test range, adjusted for atmospheric dispersion; PLANET or similar measure transmission under simulated lunar conditions
Mass of Phased Array Transmitter	Measure system mass after estimating with numerical modeling	Phased Array Transmitter	Scientific Laboratory Scale



A Few Basic Concepts: Energy Density and Population Potential

Energy Flux Density

Energy Density and Energy Flux Density are Keys to Successful Development of the near Solar System and Ensure Growing Relative Potential Population Density.

Energy sources must offer high power-to-weight ratio, ability to withstand delivery, years of maintenance-free service, steady supply, increased surplus energy of the system (thermodynamic efficiency), durability in the Lunar environment, and modularity.

Energy Density can be measured in kWe/kg. Energy Flux Density is a different construct. It is a measure of the organization of the energy supplied. One day, a high-temperature fusion plasma lunar reactors will have higher energy flux density than nuclear fission power plants with the same power output.

Energy Density and Energy Flux Density

Energy Density and Energy Flux Density are the Keys to Successful Development of the near Solar System and Ensure Growing Relative Potential Population Density.   The Moon currently supports no human populations with in-site resources or development. Large amounts of power will be needed quickly for construction of tunnel and underground spaces, as well as the Lunar economy in general.

Relative Potential Population Density is a measurement of the amount of land, with physical improvements, that can support a given number of people. Energy sources must be sufficient to support a growing scientifically and industrial population. [2]

We propose that Lunergy's architecture is a step towards growing mankind's relative potential population density, a key metric for a successful lunar physical economy.

Headline Financial Metrics — V33 Base Case

Metric	Pre-Tax	After-Tax
Internal Rate of Return	16.87%	25.84%
NPV at WACC (10.99%)	$3.32 B	$6.09 B
Levelized Cost of Energy (DOE/EIA discounted)	$73.60/kWh	—
Payback Period	Year 13	—
Equity IRR (post-debt-service)	15.68%	23.67%
Min DSCR (debt years 3–17)	4.56×	—
Tax Shield NPV	—	$2.77 B
Terminal Value (Year 30, 10× EBITDA – $455M)	$42.6 B	$42.6 B
P(IRR > WACC), 10K-iter Monte Carlo	85.5%	85.5%
Total Revenue (30-year)	$77.4 B	$77.4 B

CLOSING SUMMARY: Lunergy represents a fundamental shift in how lunar surface power is conceived: from a mission-specific support function to shared civil infrastructure. Sustained lunar activity will require more than independent landers, habitats, and science payloads operating on isolated power systems. A durable lunar economy depends on common utilities that reduce duplicated mass, simplify mission design, and enable operators to focus on exploration, science, construction, resource extraction, and industrial output rather than power generation.

REFERENCES

[1] Greg Griffitt; Jacob Goldblatt; Shukrullah Kamal; Vincent Mirolli; Riley Royall; John C Smith, Jr., PE; Jonathan Yandle, *LUNERGY: A Proposed Lunar Utility Scalable to One Megawatt*, SPRS 592 Project Submittal, Colorado School of Mines, 08 May 2026
[2] Executive Intelligence Review, *"So, You Wish to Learn About Economics?"*, 1984
[3] Gemini AI rendering, May 2026
[4] Boyle, Alan, *Why NASA Is Going Nuclear for America's Power Plan on the Moon*, geekwire.com, 30 January 2026, https://www.geekwire.com/2026/why-nasa-is-going-nuclear-for-americas-power-play-on-the-moon/
[5] Foust, Jeff, *From Advice to Action on Space Nuclear Power*, 22 September 2025,*The Space Review*, *https://www.thespacereview.com/articl e/5065/1*