LUNAR RESOURCES

The Use of Lunar Resources for Energy Generation on the Moon

Lunar Resources, Inc.
Houston, TX

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Most Critical Needs on the Moon

1. **Electrical Energy**
2. **Electrical Energy**
3. **Electrical Energy**

Regolith Transport, Lunar Water Extraction, Communication, Life Support, Construction….

ALL REQUIRES ELECTRICAL POWER

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Lunar Electricity Power Requirements

- **Electrical Power Grid Requirements**
  - Scalable
  - Deliver electricity to multiple locations
  - Redundant Systems (Backup Systems)
  - Low-Cost (Exponential Cost Curve)

- **Electrical Power Needs**
  - Initial (2024-2028): 100kW to 1 MW
  - With Time (2035): 10's to 100's MW
  - Far Future (2040+): GW to TW

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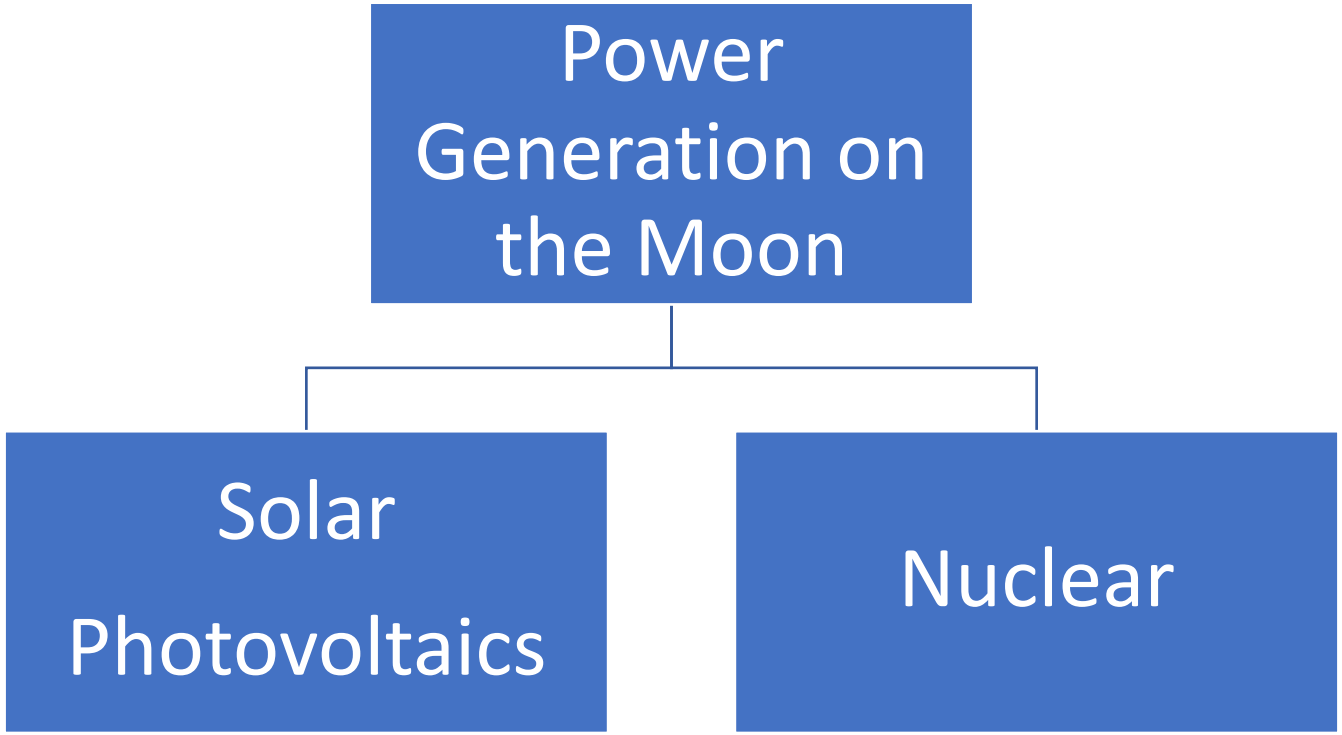
Options To Generate Energy on the Moon



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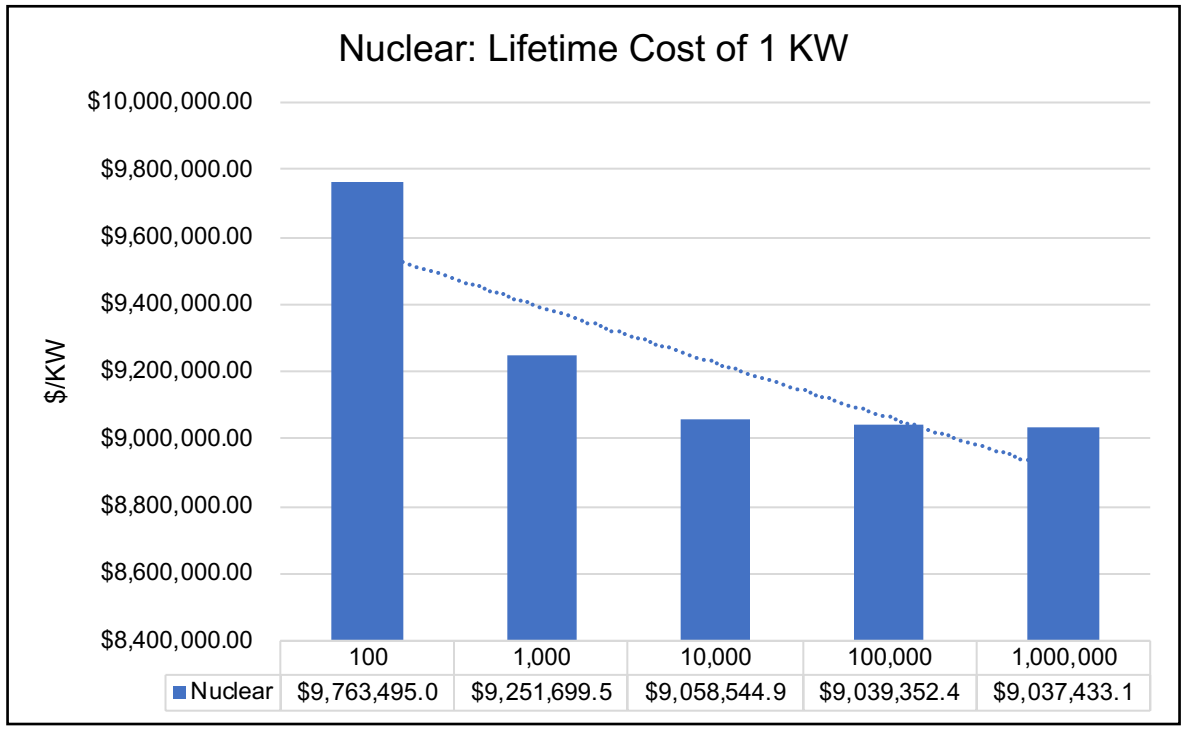
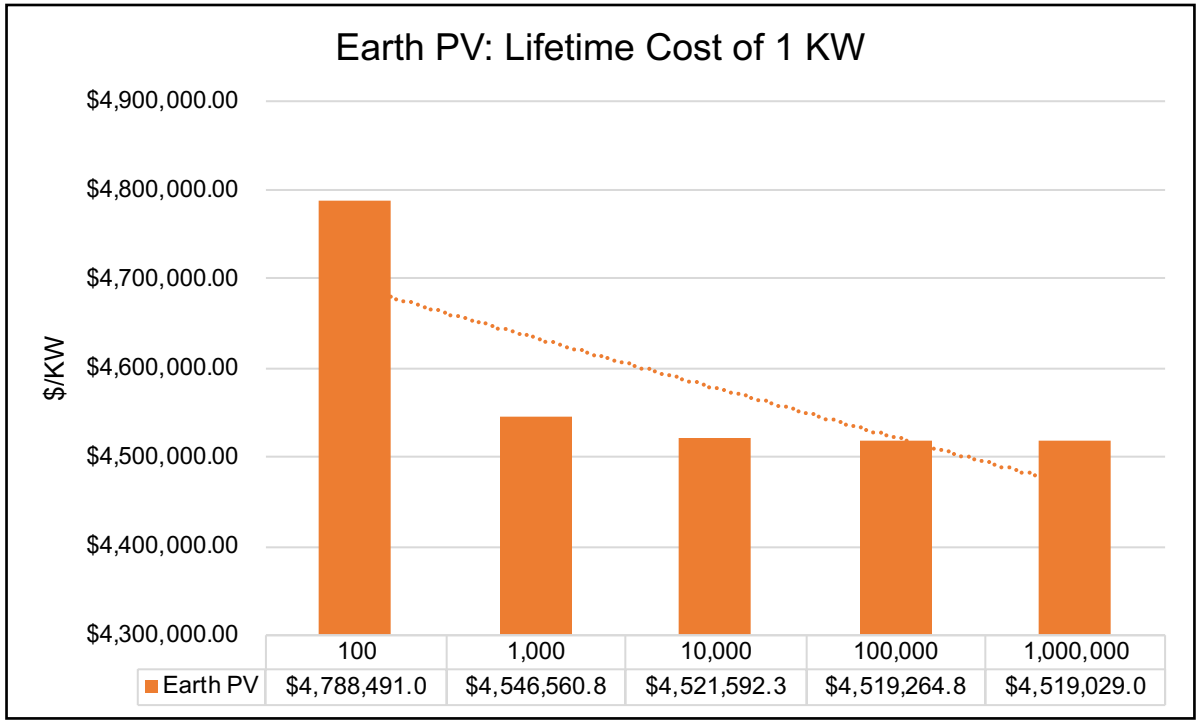
Cost Curve of Earth Transported Power Generation Systems on the Moon





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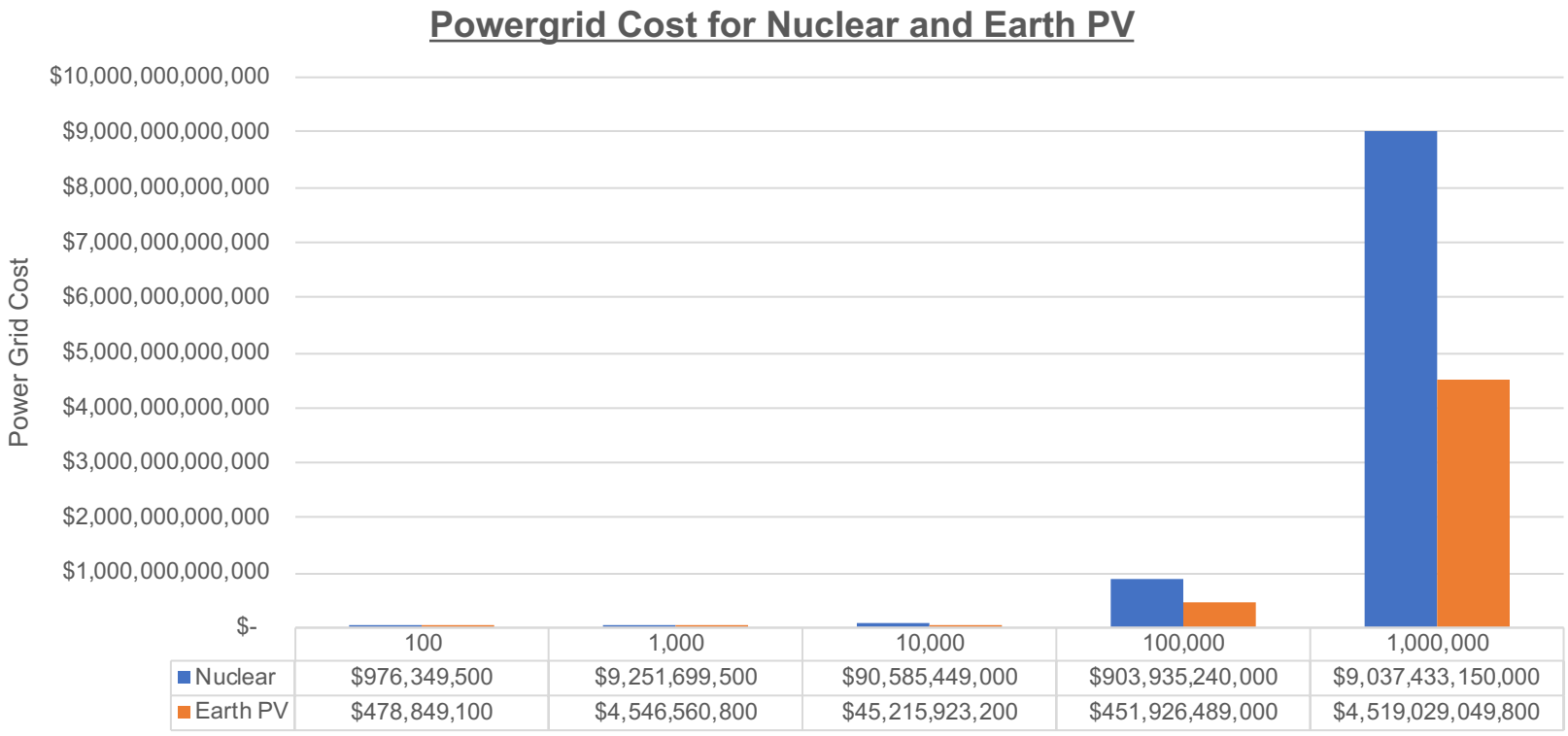
Problems of Powergrid with a Linear Cost Curve Profile

- Cost of your first KW produced is same as your last KW produced
- Cost reduction of lunar products or resources will have a theoretical limit
- Limit is a factor of launch cost and cost of manufacturing assets on Earth



	100	1,000	10,000	100,000	1,000,000
Nuclear	$976,349,500	$9,251,699,500	$90,585,449,000	$903,935,240,000	$9,037,433,150,000
Earth PV	$478,849,100	$4,546,560,800	$45,215,923,200	$451,926,489,000	$4,519,029,049,800

Cheaper to make products on Earth!

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How to Develop a (near) Exponential Cost Curve

- Eliminate launch (after initial launch)
- Utilize Lunar Resources
- Leverage In-Situ Environment
- Make the Lunar Power Grid In-Situ

Lunar Resources, Inc. was established to develop, deploy and operate the technology to enable for an exponential electrical power grid cost curve on the Moon

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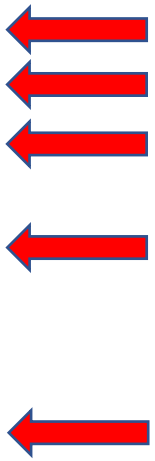
Available In-Situ Lunar Resources

Lunar Element Resources

O	42.3107668
Si	19.725546
Ti	4.674852
Al	7.1978
Cr	0.20526
Fe	11.89269
Mn	0.154892
Mg	4.703712
Ca	8.504811
Na	0.3486742
K	0.132824
P	0.028172
S	0.12



Lunar Environment

- The Moon has a Unique Ultra-High Vacuum Environment
  - Lunar Day: $10x10^{-10}$ Tor
  - Lunar Night: $10x10^{-12}$ Tor
- Solar
  - Average Power Sq. Meter: 1368W

Si + Al/Fe/Ca + High Vacuum + Solar Energy = Photovoltaic Power

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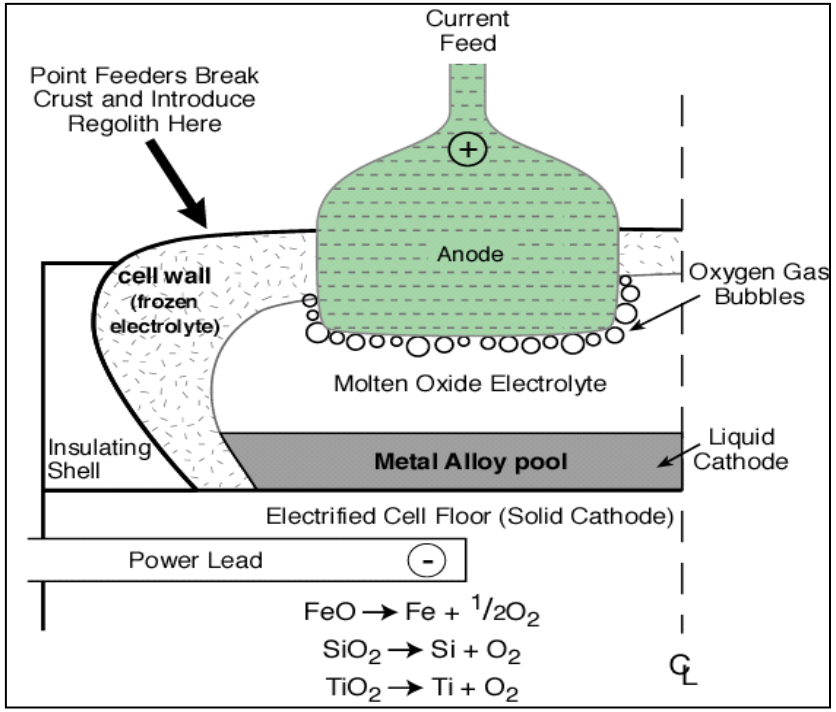
Production of Solar Cell on the Moon

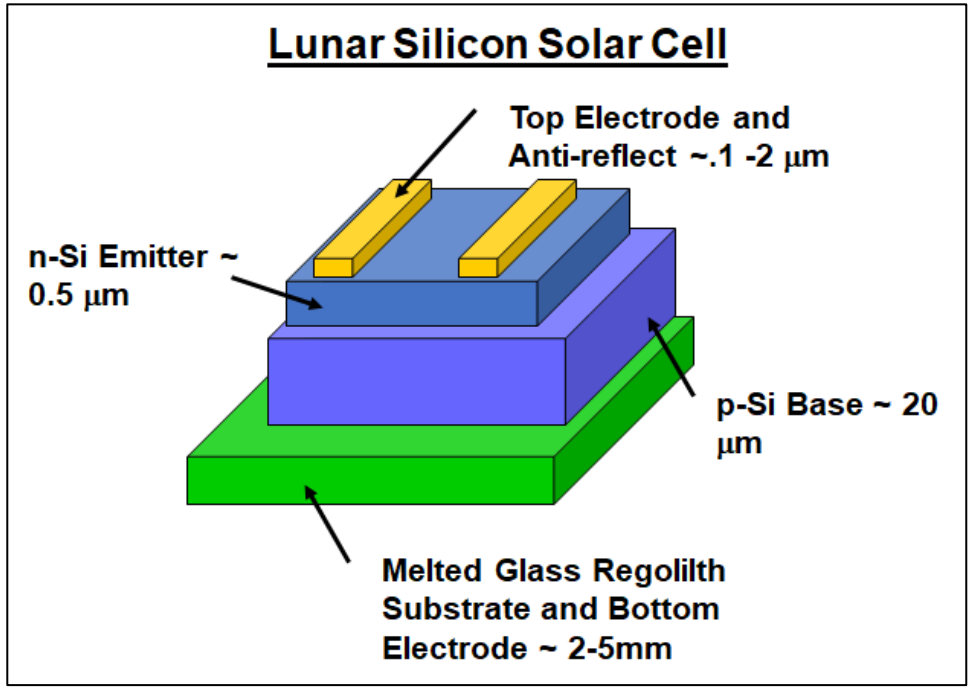
Resource Extraction/Refinement

Molten Regolith Electrolysis



In-Situ Solar Cell

Vacuum Vapor Deposition



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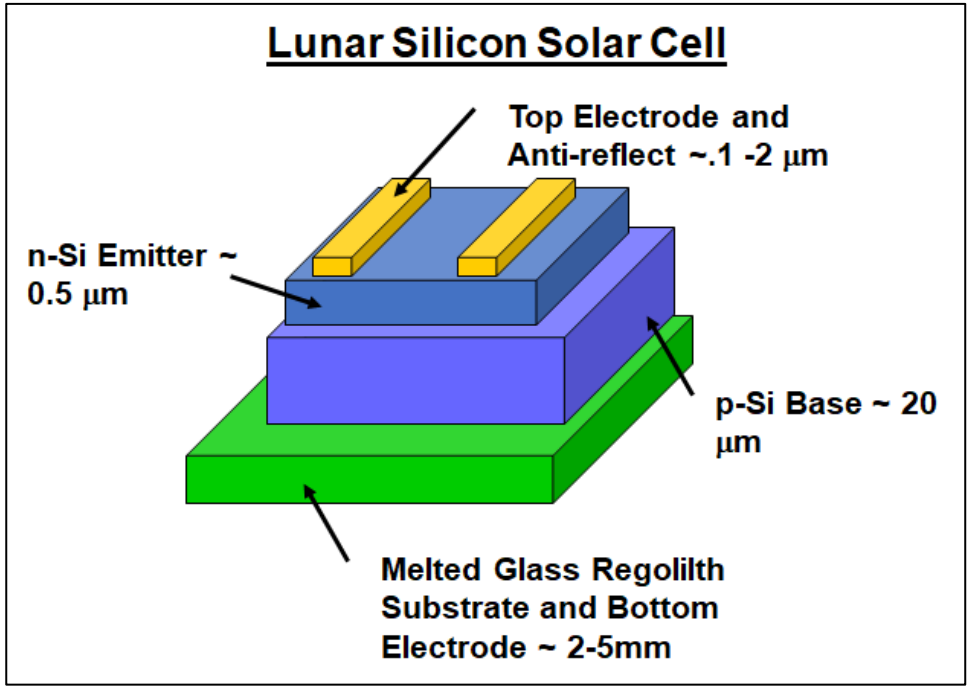
Lunar In-Situ Solar Cells

- **Substrate** - Melted Regolith 'Glass'
- **Bottom Electrode** – Al
  - **Silicon** – co-doped
  - **Metallization** - Top Electrode
    - Al
    - Evaporation through contact mask (electrode pattern)
  - **Anti-reflection** Coating
    - TiO_2 , SiO_2, or evap. Regolith
  - Cell **Interconnects**/Power Grid
    - Thin film metals (Al, Fe, Ca….)



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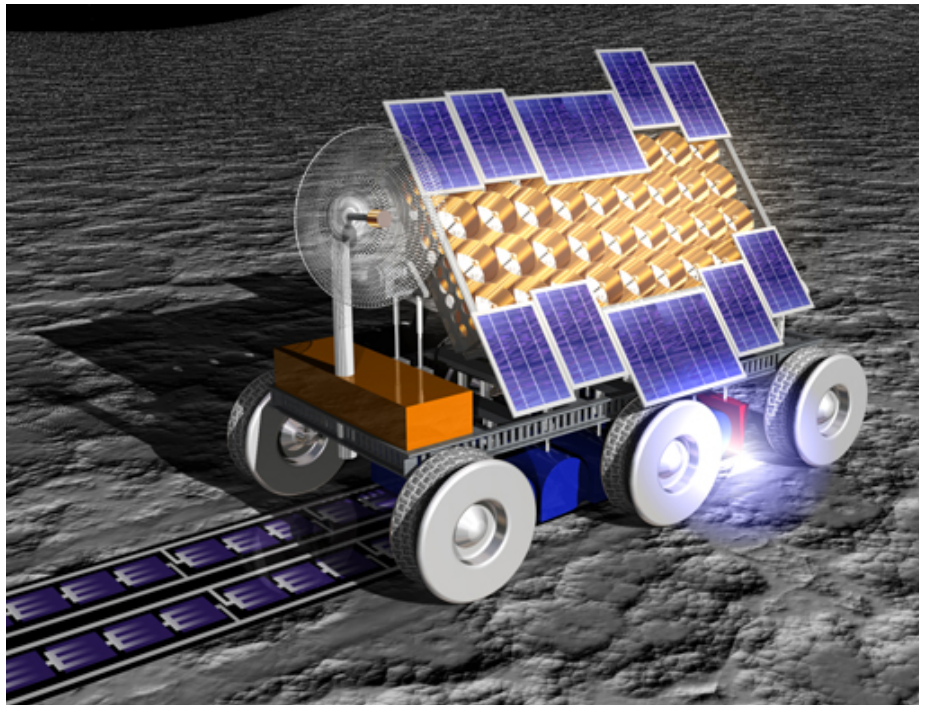
Lunar Resources Lunar Deposition Paver

Lunar Deposition Paver

- Mechanized Thin Film Growth Facility
- Mass: 200 kg
- Thermal Energy to melt regolith and vaporize elements
- PV panels for motive/control power
- Continuous lay-out of cells on lunar surface
- Pre-loaded with initial amount of raw materials



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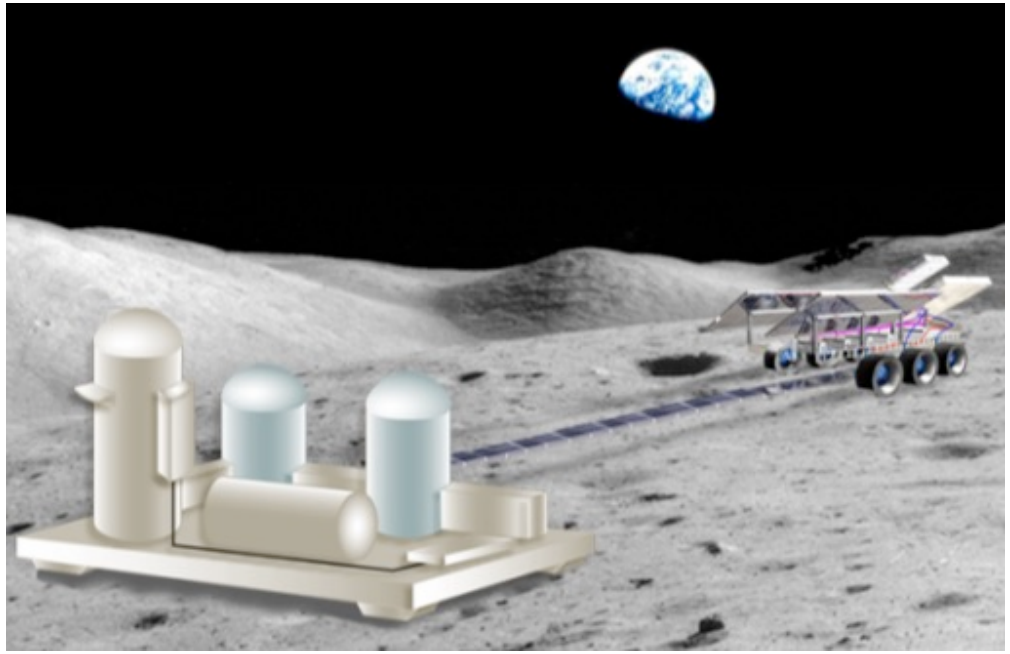
Lunar Resources Molten Regolith Electrolysis Facility

Molten Regolith Electrolysis Facility

- Regolith Processing Facility: Si and Metals Extractor
- Mass: ~ 150 kg
- Regolith scoop
- Solar thermal and electric heat (connect to solar cell field)



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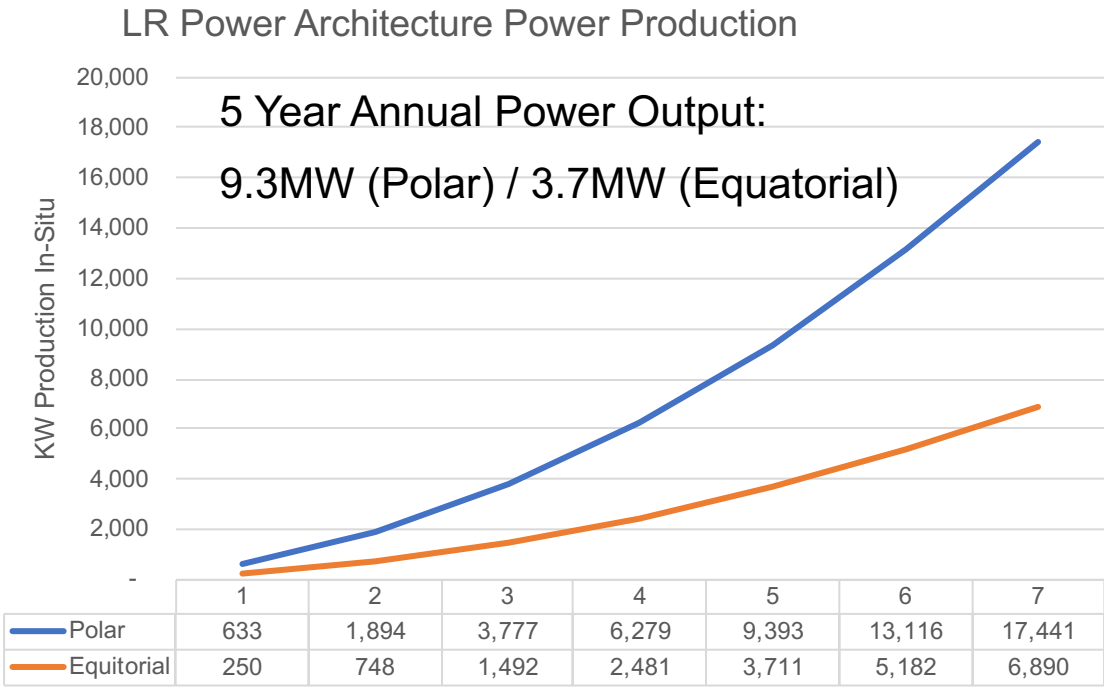
Lunar Resources Surface Asset Architecture

Lunar Resources Power Asset Profile

- Total Mass: <500kg
- Architecture Lifetime: ~10 Years
- Scalable Power Grid
- Construct Localized and Central Powergrid
- High Power Output
- Exponential Cost Curve



	1	2	3	4	5	6	7
Polar	633	1,894	3,777	6,279	9,393	13,116	17,441
Equitorial	250	748	1,492	2,481	3,711	5,182	6,890

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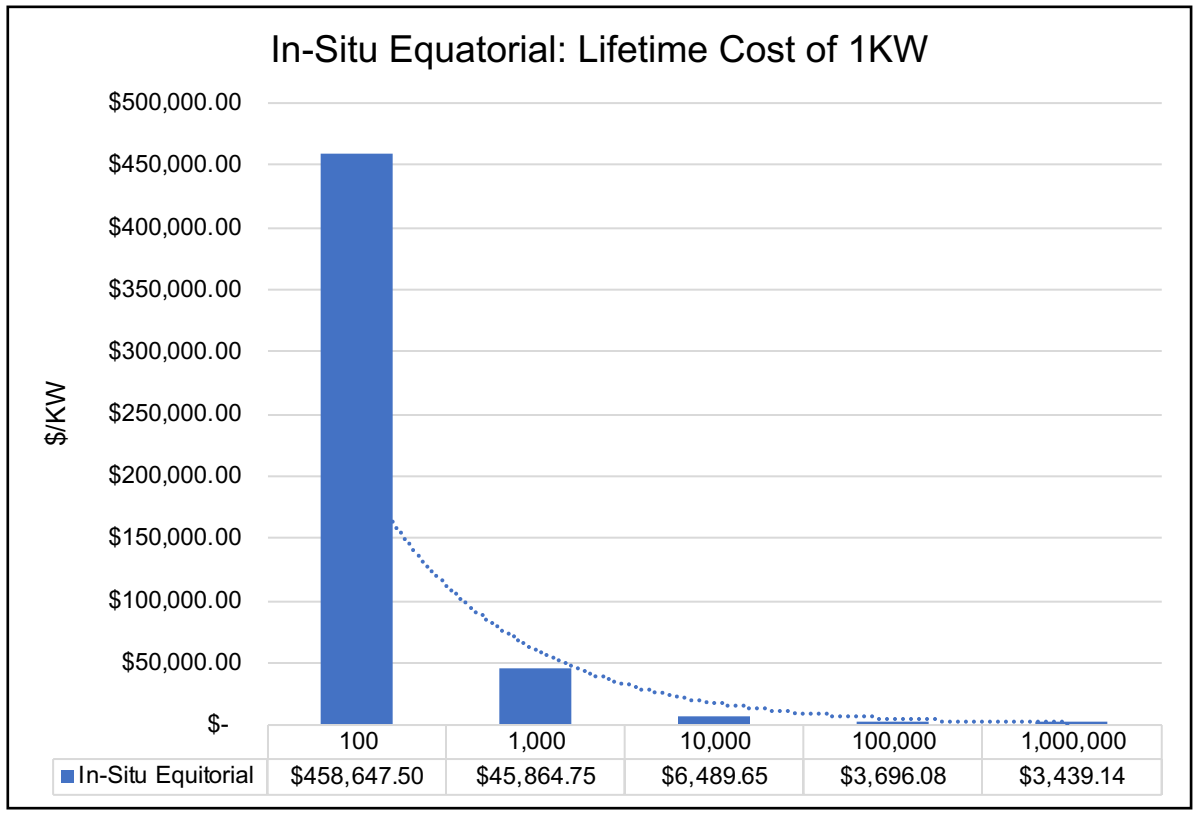
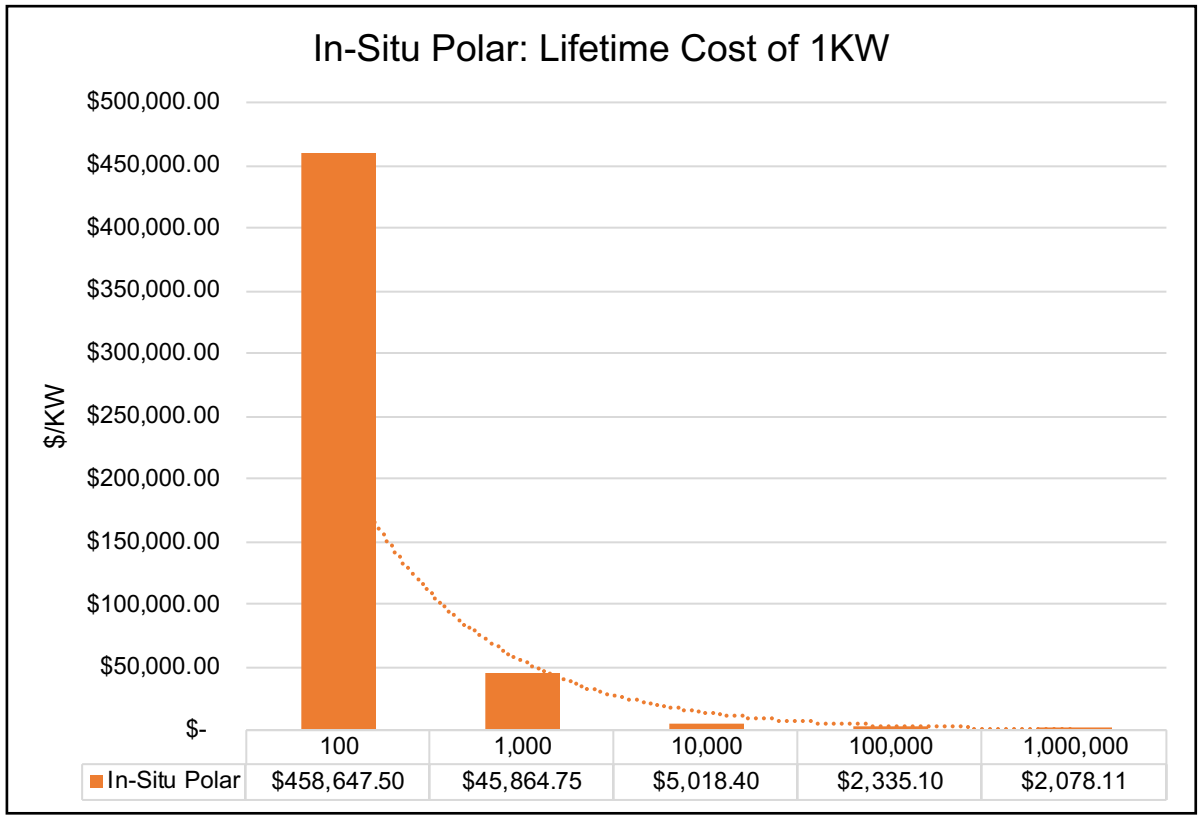
Cost Curve of In-Situ Lunar Power Grid





Building blocks for a sustainable Lunar economy

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