



Evaluating Lunar Water Processing System Model Configurations for Small Scale Oxygen and Hydrogen Production Within JAXA's ISRU Technology

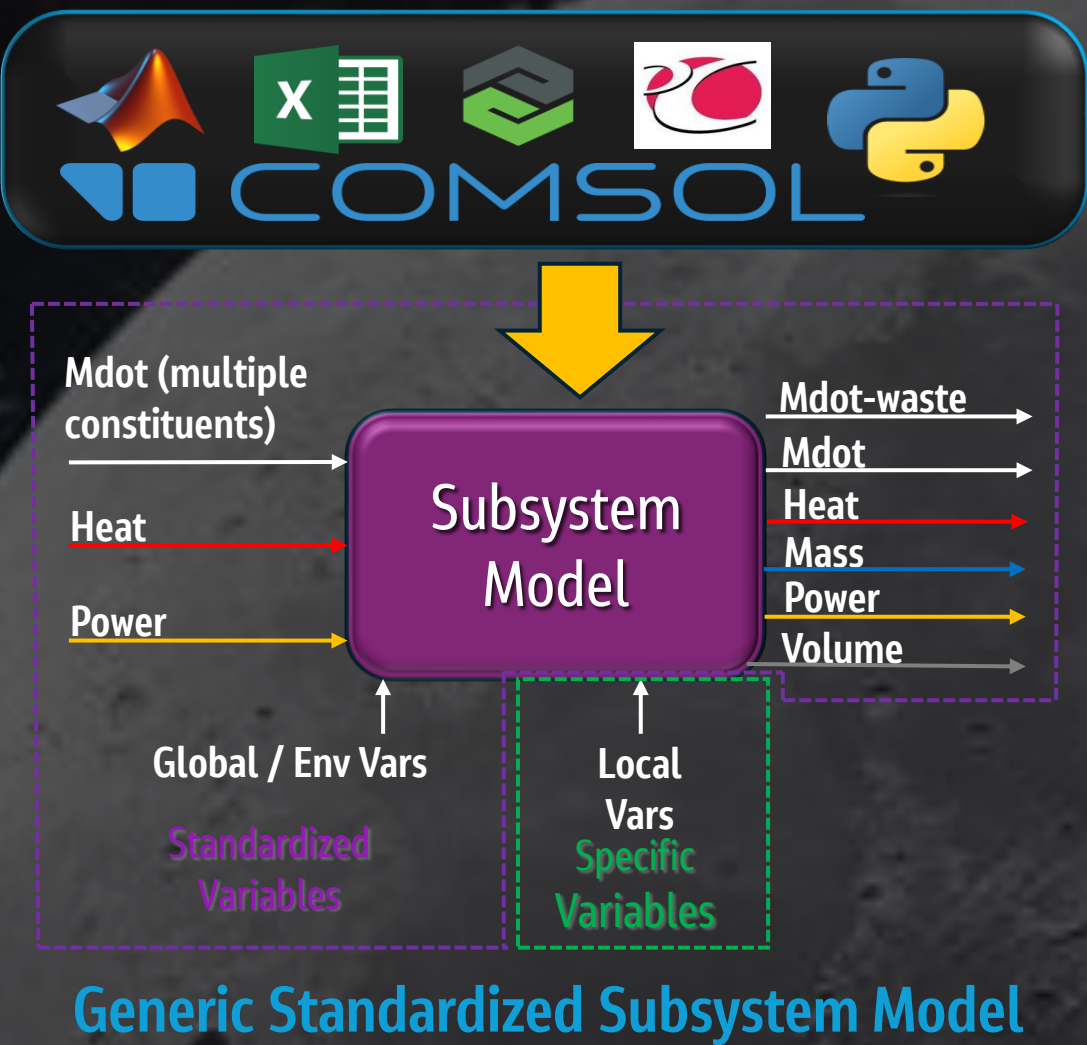
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System Engineering & Integration (SE&I)
In-Situ Resource Utilization (ISRU) Modeling and Analysis (SIMA)



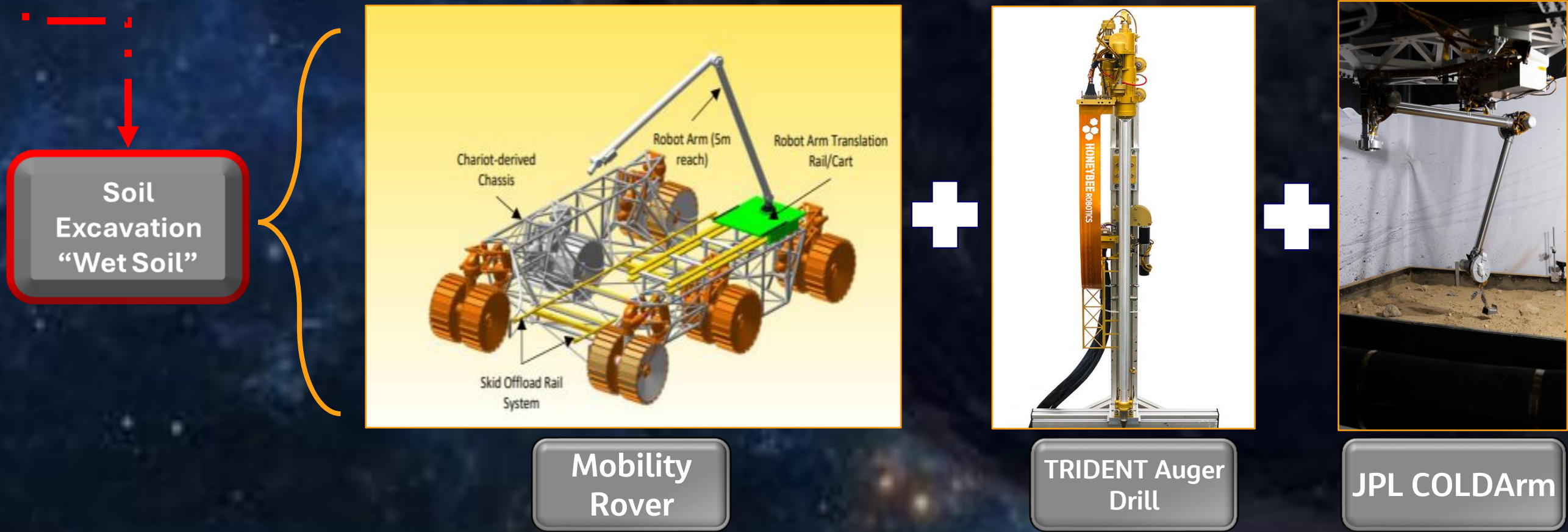
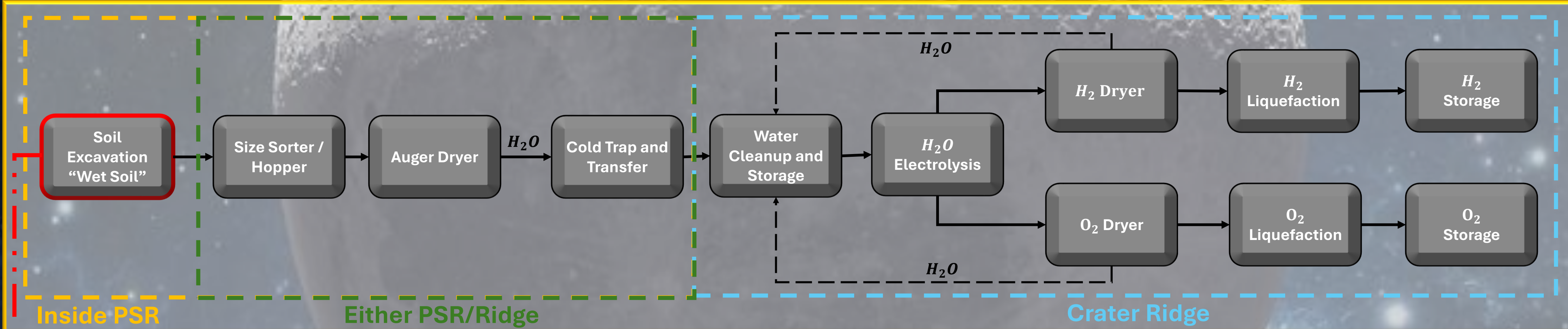
SIMA Description

- Flexible system modeling framework of ISRU subsystems, built in MATLAB/Simulink, designed to communicate with numerous commercial software's via API's.
- Provides detailed understanding of mass, volume, and power of critical ISRU technologies for numerous mission architectures at differing production targets.
- Identifies key optimization & new technology shortfalls through system level parametric studies.



Study Goals

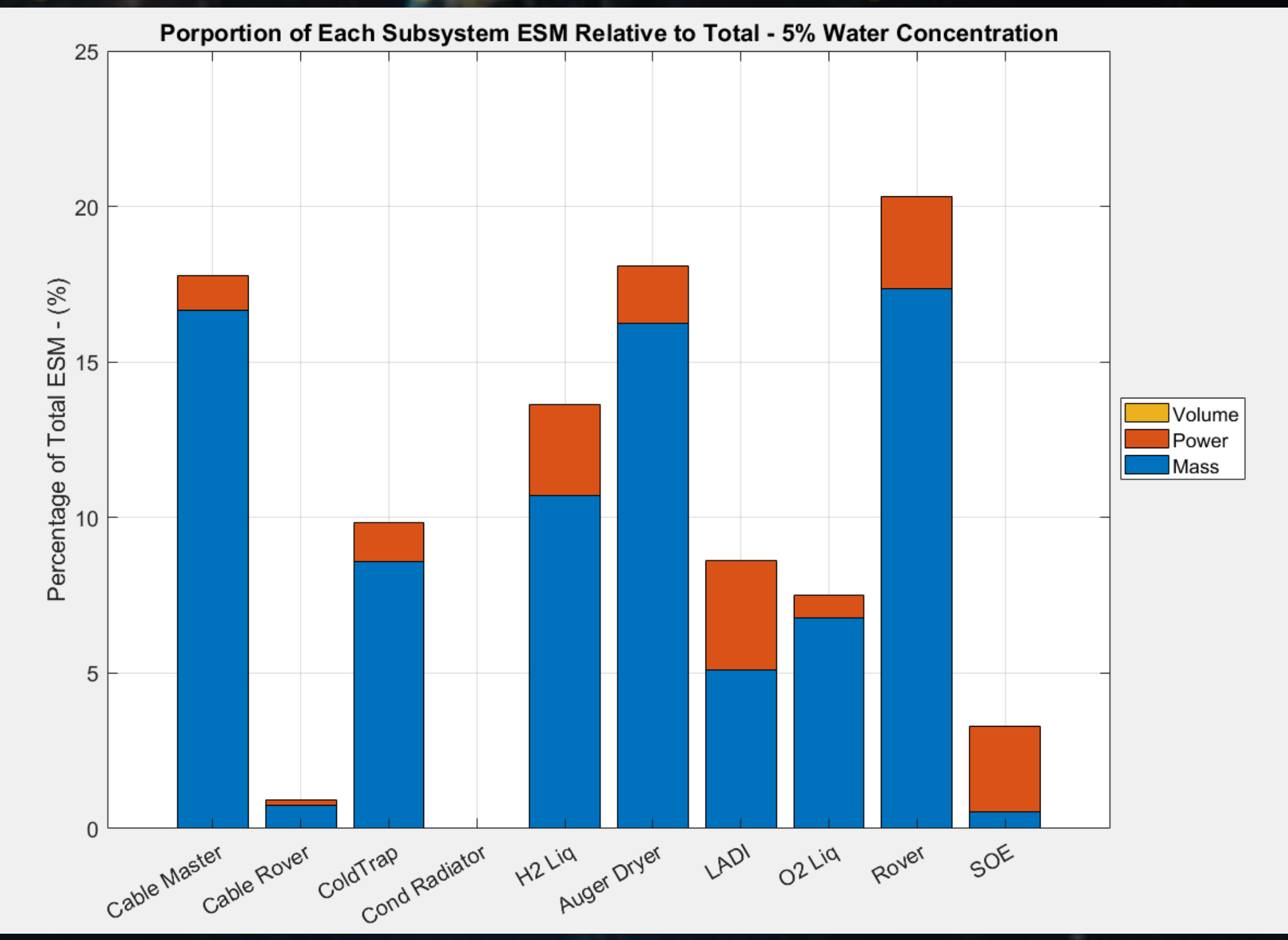
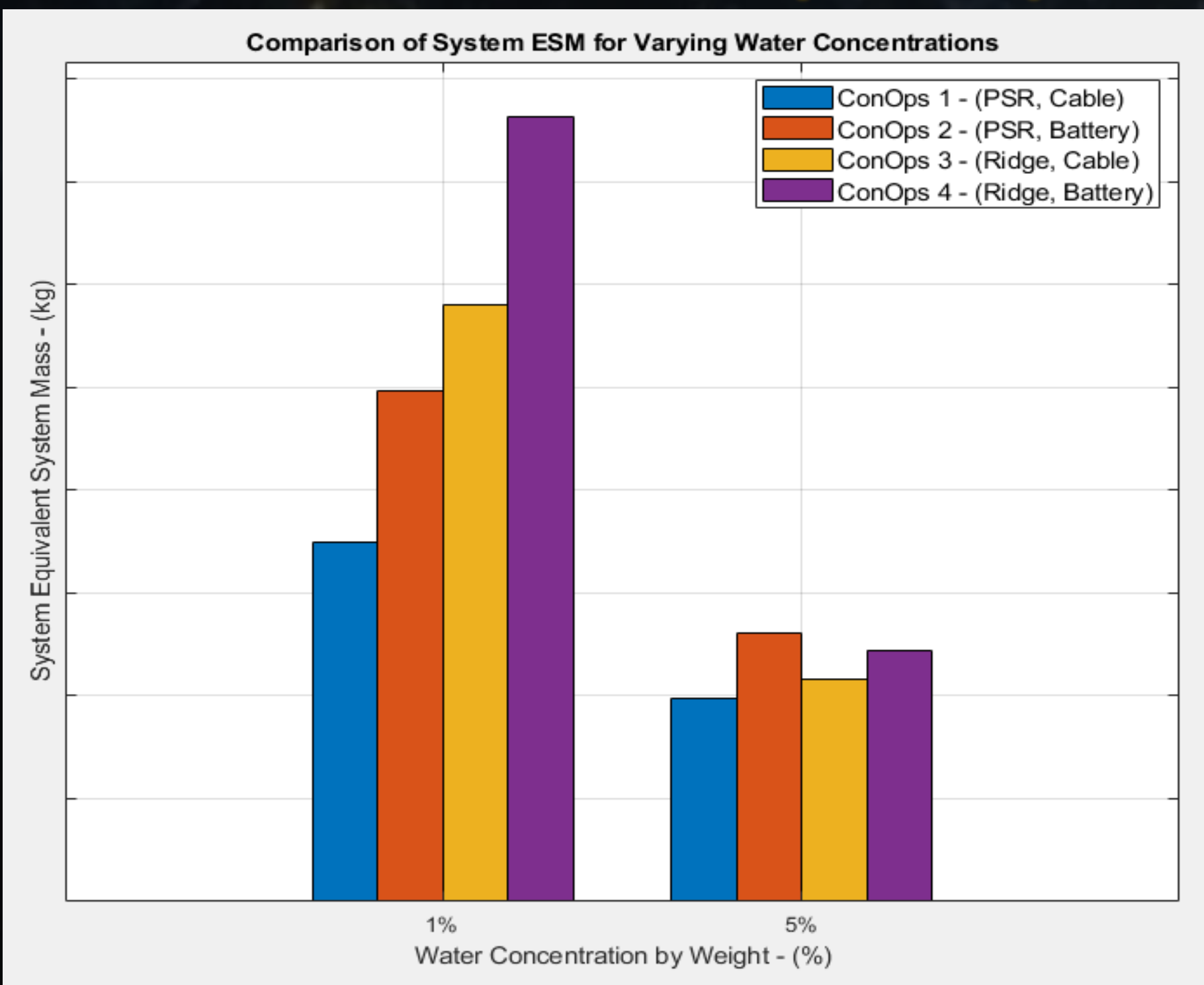
- Determine feasibility of regolith excavation and transportation to crater ridge via small scale ISRU plant.
 - With unknown water-ice concentrations embedded within lunar regolith, JAXA wants to analyze the effect on ISRU system mass, volume, power, and equivalent system mass (ESM) for:
 - 1) Transporting excavated regolith to crater ridge for regolith processing and O_2 and H_2 generation.
 - 2) Processing regolith within PSR with *only* water being transported to crater ridge.
- Evaluate effect of different power system integrations for each ConOps.
 - For both logistical ConOps listed above, the excavation rover will either be powered via on-board, rechargeable Li-ion batteries, or through a cable connecting the rover to standalone power (VSAT) on crater ridge.
- Develop system model for new excavation techniques for unknown ice depositions within permanently shadowed region (PSR).
 - TRIDENT + COLDArm proven for consolidated icy regolith.
 - KSC IPEX (rotary drum excavator) proven for granular ice depositions.
- Overall production targets of 340 kg/yr potable H_2O , 150 kg/yr O_2



Four ConOps of Investigation

	Cable Power to Rover	Battery Power to Rover
PSR Processing of Regolith	ConOps 1	ConOps 2
Ridge Processing of Regolith	ConOps 3	ConOps 4

Results – ConOps Comparison & Optimal Configuration (ConOps 1)



Takeaway One

- Processing the regolith within the PSR trades better than bringing the regolith to the crater ridge. This is more apparent at lower water concentrations:
 - 19% lower at 5% water conc.
 - 54% lower at 1% water conc.

Takeaway Two

- At low water concentrations, ISRU systems require multiple years of operation to obtain return on landed mass for this system architecture.
 - This tends to be true for most ISRU systems.

Takeaway Three

- With current battery capabilities, utilizing cable power is less mass intensive. This is especially true for large rovers/payloads. The exception is for ConOps 2 at 5% water concentration, which requires a massive master cable for recharging capabilities of the excavation rover.

Takeaway Four

- Sublimation losses while bringing regolith out of PSR (heating/agitation) require more regolith excavation to occur to account for these water losses.
 - Expected sublimation loss when processing in PSR: 30%
 - Expected sublimation loss when processing on Ridge: 63+%.