High Energy Battery Technologies Session

(≥ 400 Wh/kg at the Cell Level)

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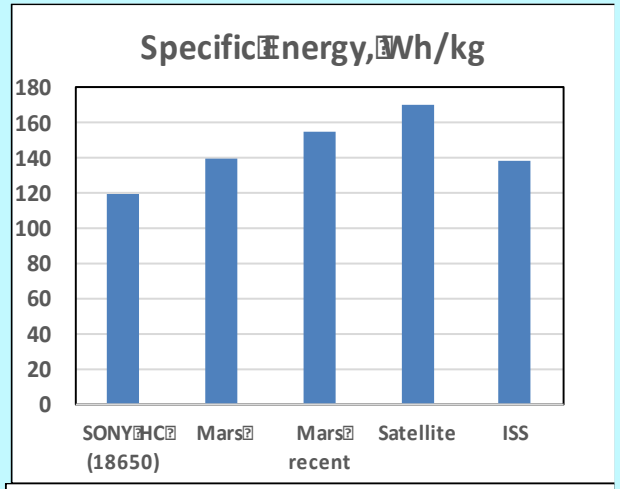
NASA Battery Workshop.

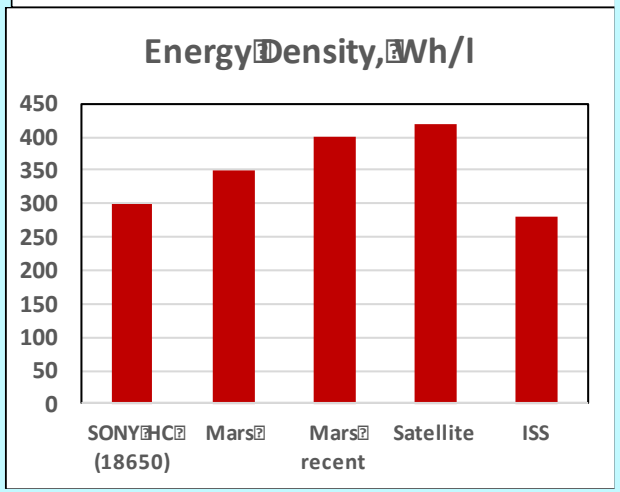
Huntsville, AL

November 14, 2017

State of Art / State of Practice

State of Practice



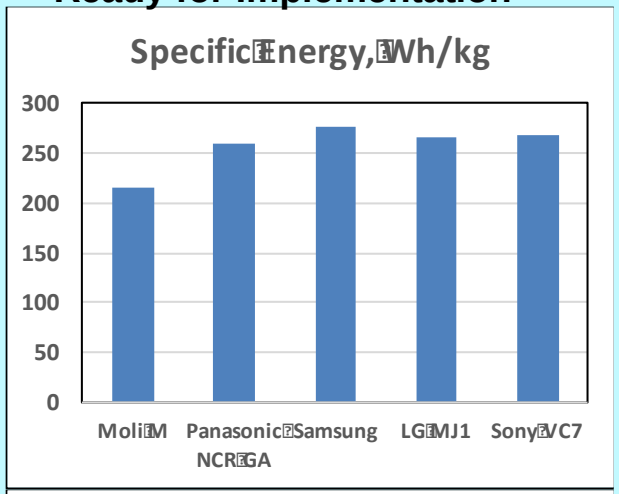


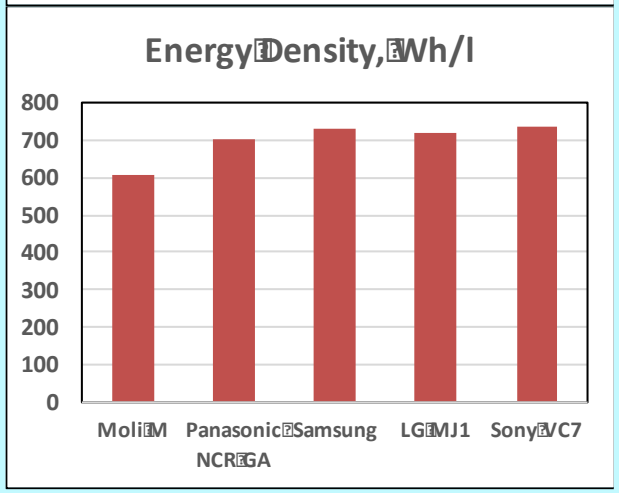
Mars Rovers/Landers, Juno, ISS, Mars Orbiters, SMAP

Chemistry

Cathode	$LiCoO_2$ (LCO)	160-200 mAh/fg
	$LiNi_{0.8}Co_{0.2}O_2$ (NCO)	
	$LiNi_{0.8}Co_{0.15}Al_{0.05}O_2$ (NCO)	
	$Li(NiCoMn)O_2$	
Anode	MCMB	280-350 mAh/g
	Hard Carbon	
	Graphite	
	Small amount of Si?	
Electrolyte	Organic Liquids (carbonate blends, ester co-solvents, additives)	
Cell Configuration	Large format Prismatic or Cylindrical cells	Cell Balancing
	Small 18650 cells	No Cell Balancing

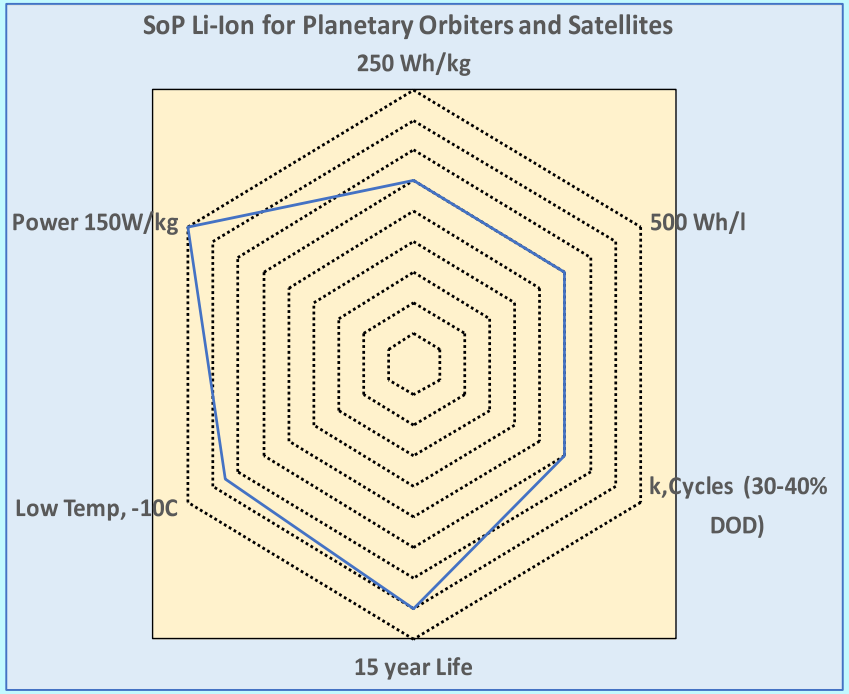
State of Art
Ready for Implementation

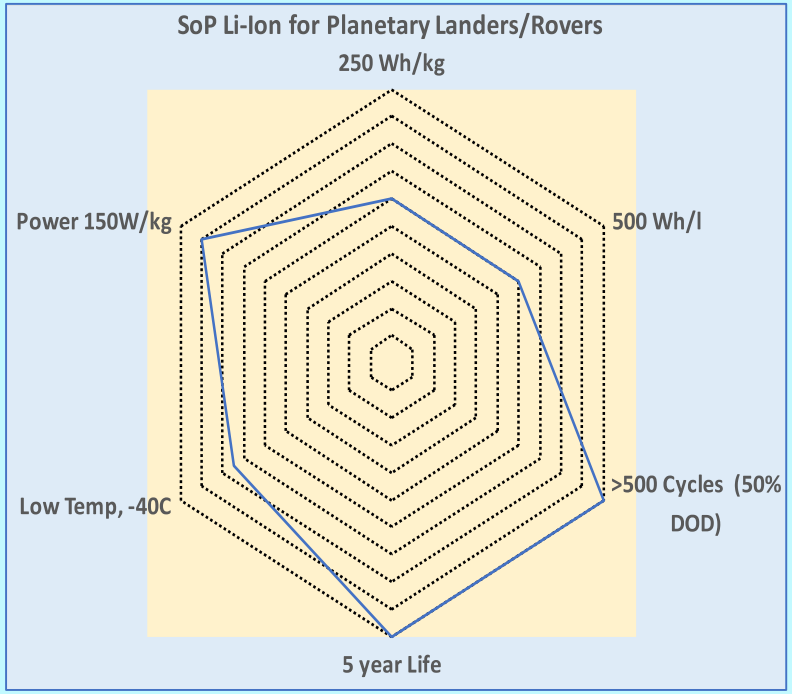


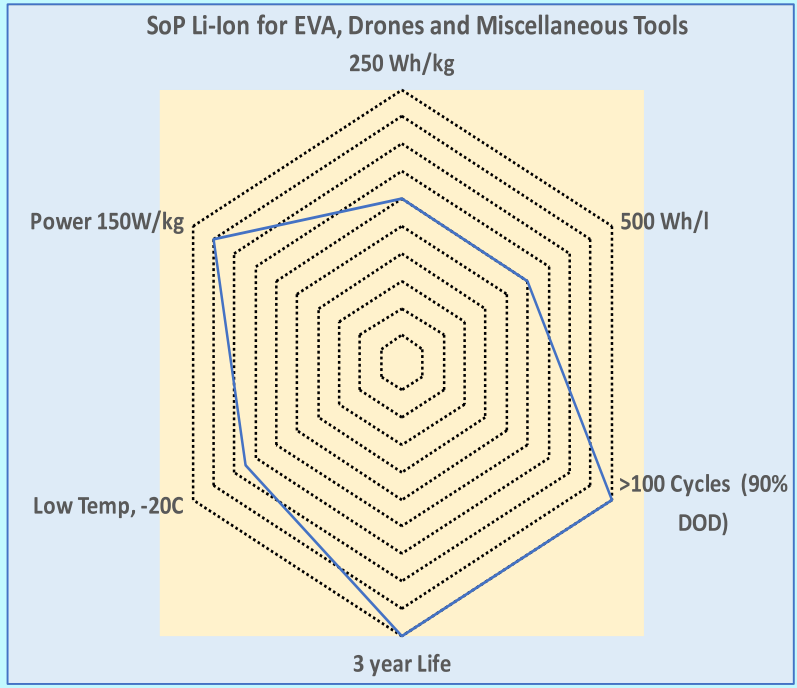


Europa Clipper, EVA, Orion?

Energy Storage Needs of Future Planetary Missions





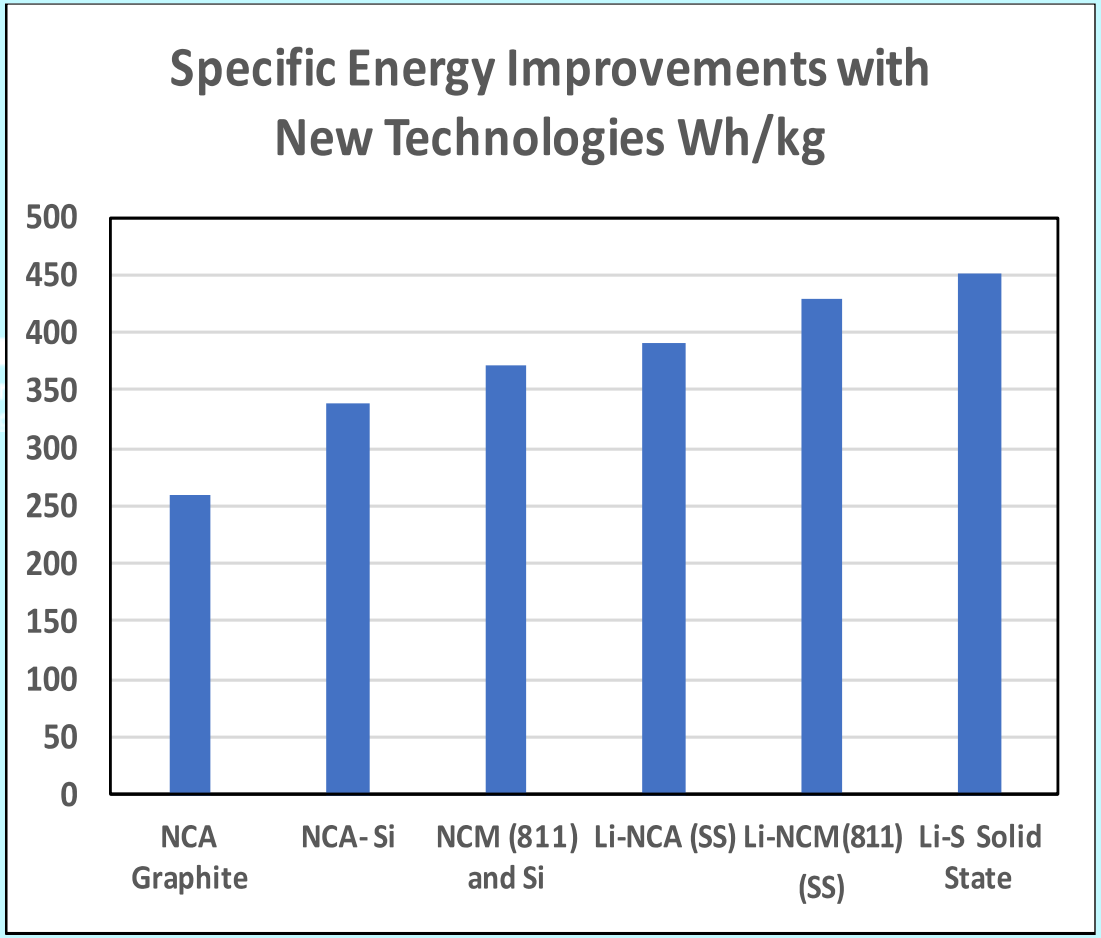


- Based on the recent review on Energy Storage Technologies for Planetary Missions

- High specific energy batteries are deemed necessary for (and beneficial to) several future missions.
- These high specific energies are not achievable with Li-ion batteries. (250 Wh/kg at the battery level or 400 Wh/kg at the cell level)
- Several missions with modest cycle life requirements exist (e.g., UAVs, Smallsats, EVA etc.) which may be the targets for the advanced technologies

Advanced Rechargeable Battery Technologies
(to be discussed today)

Advanced Technologies

Electrode	Options	Characteristics	Challenges
Cathode	NCM 811	230 mAh/g at 4.3 V	Cycling, Metal dissolution (Tiax)
	Li-rich NMC	240 mAh/g at 4.5 V	Voltage fade, cycling
	Sulfur	>800 mAh/g	Polysulfide shuttle (Sion, EPT, Navitas)
Anode	Silicon	>800 mAh/g at 0.2 V	Volume expansion, irreversible capacity, cycling (Amprius)
	Lithium	>1000 mAh/g	Dendrites in liquid electrolytes
			Solid Electrolytes: Stability, Scale up (Univ. Maryland)
			Molten Salts- Stability with Li (Cuberg)

Performance Projections