LYTEN

Lyten's High Energy Lithium-Sulfur Batteries for DoD Applications

Jim Paye
VP Business Development
June 6, 2024

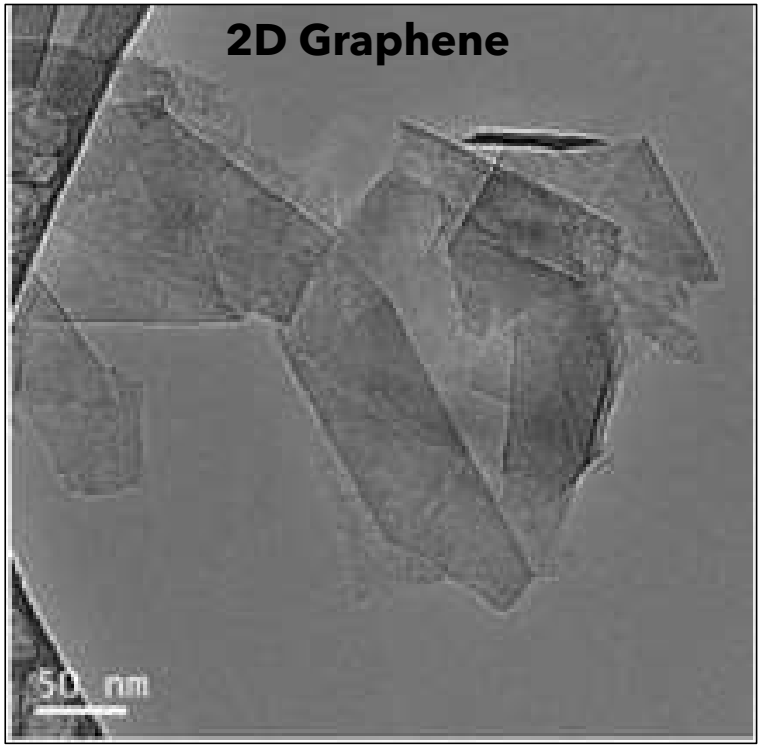
LYTEN OVERVIEW

- Founded 2015 – Produce Lyten 3D Graphene™
- Leader in 3D Graphene Patents (>370 patent matters)
- >$410M Raised Through Series A; finishing Series B
- Initial Applications of Lyten 3D Graphene™
  - Lithium-Sulfur Batteries
  - Composites
  - Sensors
  - US Government Applications
- 145k ft^2 Facilities in Silicon Valley
  - 3D Graphene Fab (2022)
  - Pilot Cell Production Line (2023)
- 420+ Filed and granted patents
- > 280 employees; >70% advanced degree holders
- Battery Team – 85 employees

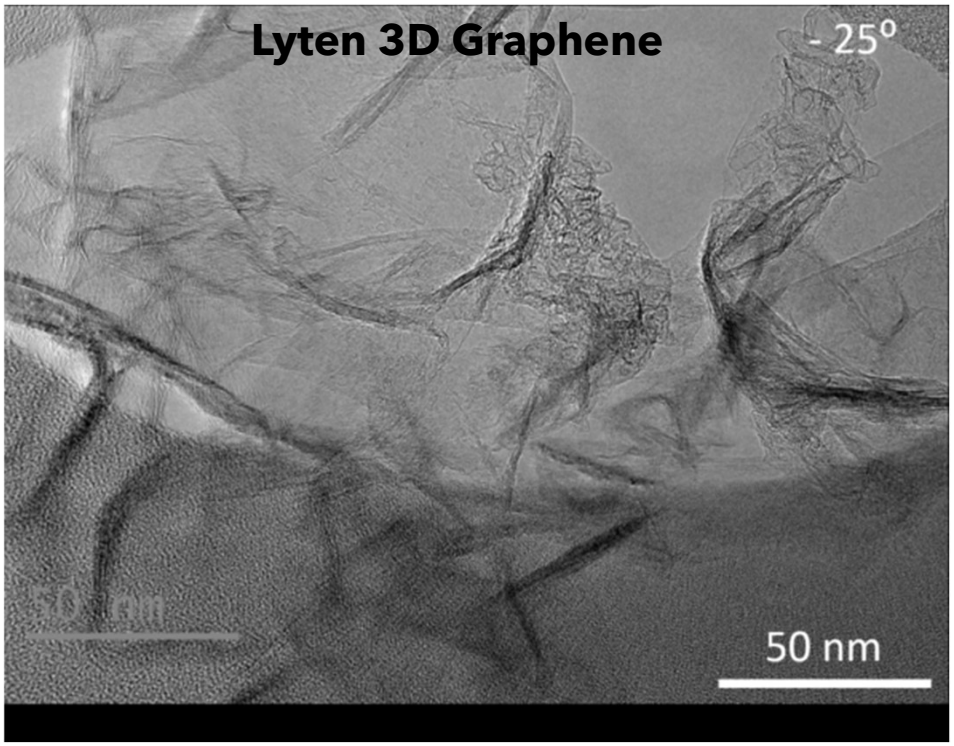
LYTEN

3D GRAPHENE: AN ENABLING BREAKTHROUGH

Proprietary manufacturing method; proprietary application tuning



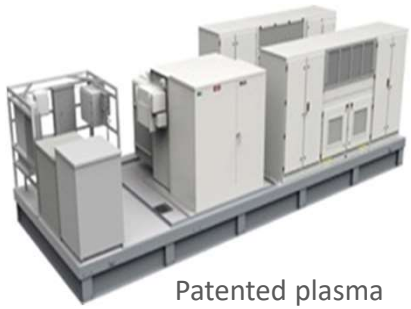
Conventional graphene: expensive with limited functionality



3D graphene: complex structure with high functionality, readily manufacturable

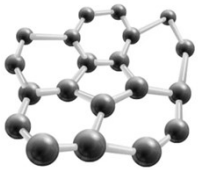
LYTEN 3D GRAPHENE™ PROCESSING

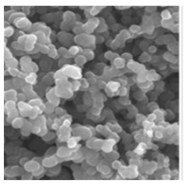
Hydrocarbons
(including biogas)

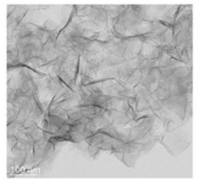


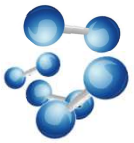
Patented plasma
reactor technology

Tunable 3D Graphene™ for product application









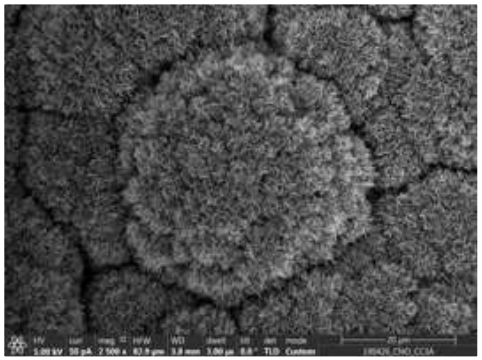
Clean Hydrogen

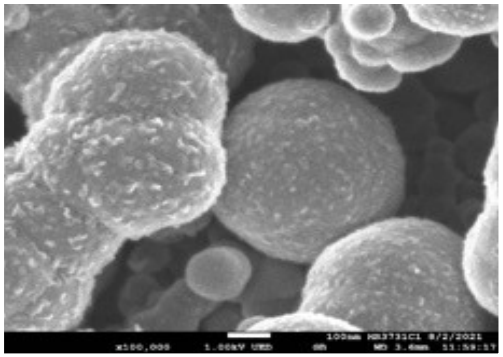
GHG Emissions Target

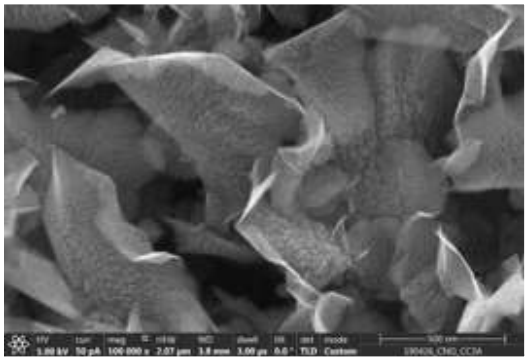
-2.5

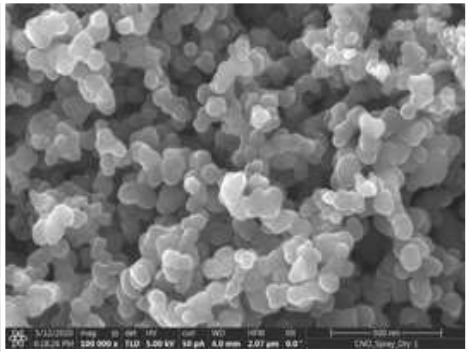
KG CO_2eq / KG 3D Graphene

Lyten 3D Graphene™ targets to be a carbon negative material at scale.*









LITHIUM SULFUR- HIGH ENERGY AND SUSTAINABLE

Key Challenges for Traditional LIBs

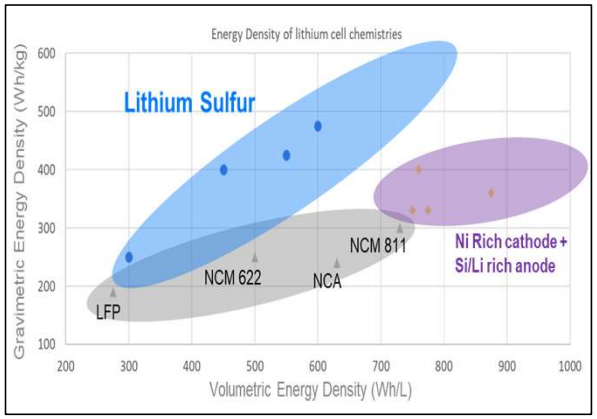
- Cell performance reaching its fundamental limits (300 Wh/kg)
- Predominantly foreign-sourced active materials causing supply chain issues and unstable (increasing) pricing
- Cobalt and nickel shortfall in coming years
- China has overwhelming dominance in the processed materials and also cell and battery manufacturing
- Safety concerns from thermal runaway are still prevalent

Key Advantages of Lithium-Sulfur Batteries

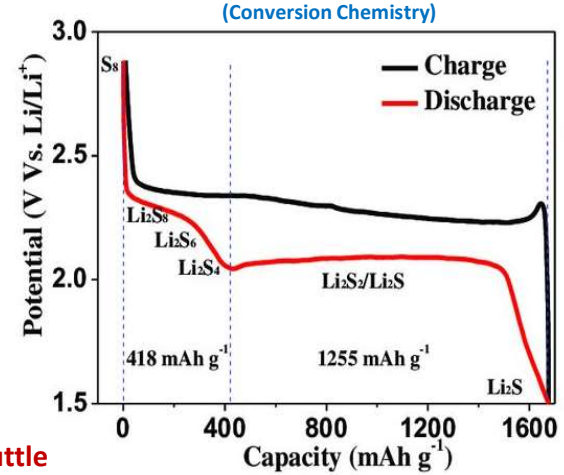
- Higher specific energy (Sulfur has 8x specific capacity vs. LIB cathode). At maturity, 600 Wh/kg and 800 Wh/L possible
- Robust domestic supply chain, free from nickel/cobalt/graphite
- Abundant, low-cost materials: sulfur and carbon
- Inherently safer than LIB due to unique chemistry
- Lyten architecture has a possible path towards low or neutral carbon footprint.

Challenge: Polysulfide shuttle

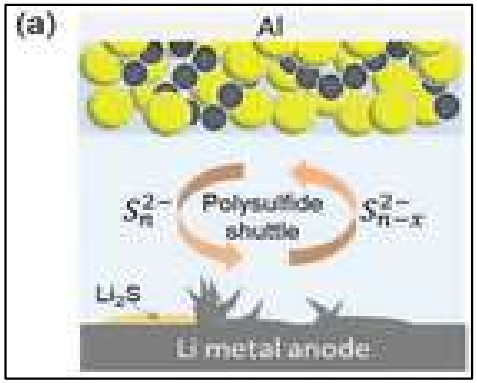
Li-S vs Li-Ion and Li-NMC Batteries



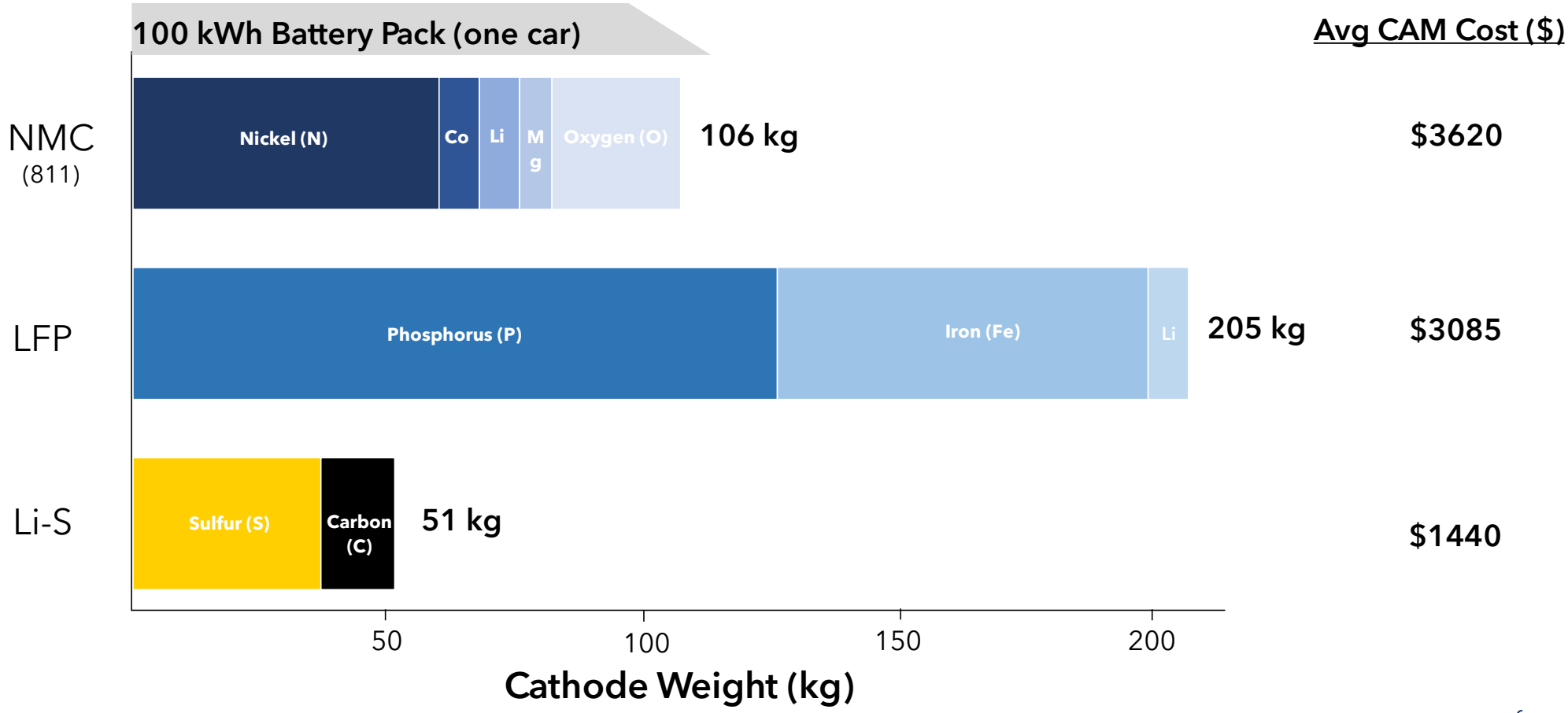
Li-S Cell Voltages (Conversion Chemistry)



Polysulfide Shuttle



CATHODE RAW MATERIAL WEIGHT & COST (2030)



LIFE CYCLE ANALYSIS (CARBON FOOTPRINT)

- Lyten Li-S LCA estimates a carbon footprint of 24.5 kg CO2eq / kWh at scale.
- Result is 50% lower than any other battery in comparison group of 28 batteries from 10 peer reviewed LCAs. Lyten result is 80% lower than the mean of all batteries.
- Lyten working on a pathway to drive the carbon footprint Li-S towards or past carbon neutral.

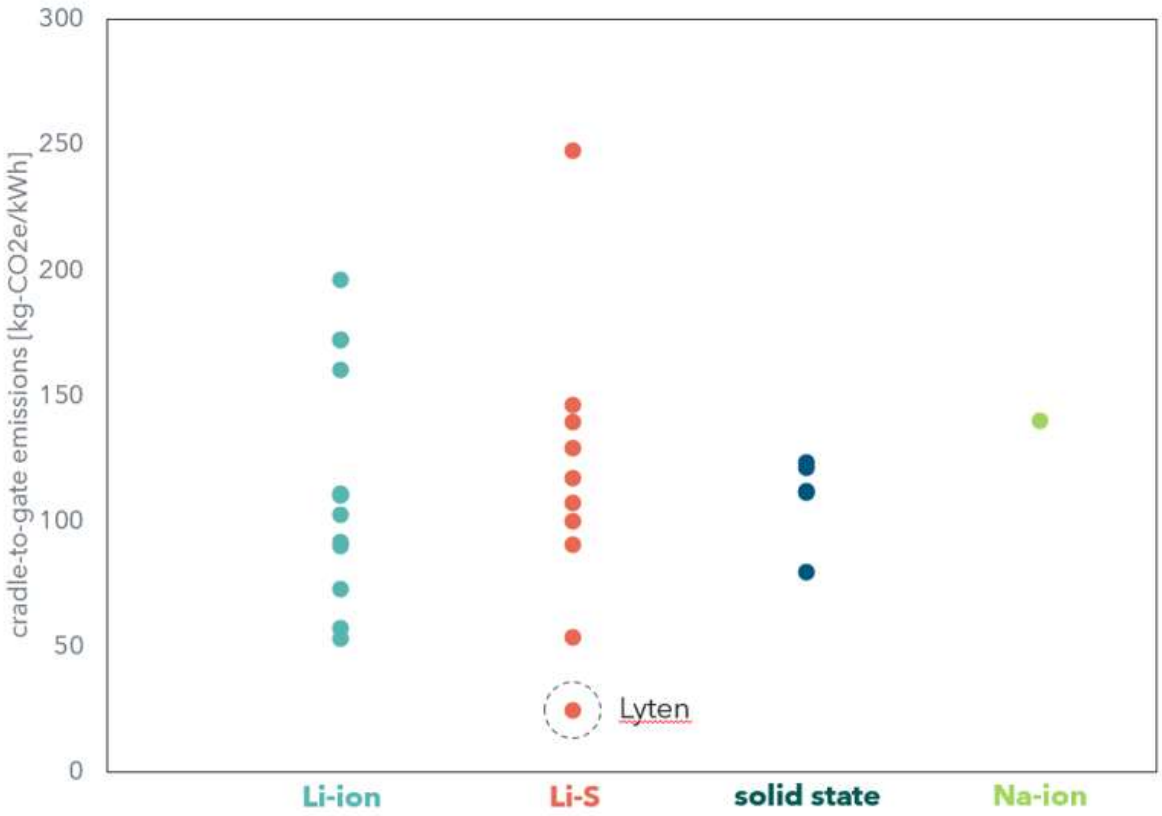
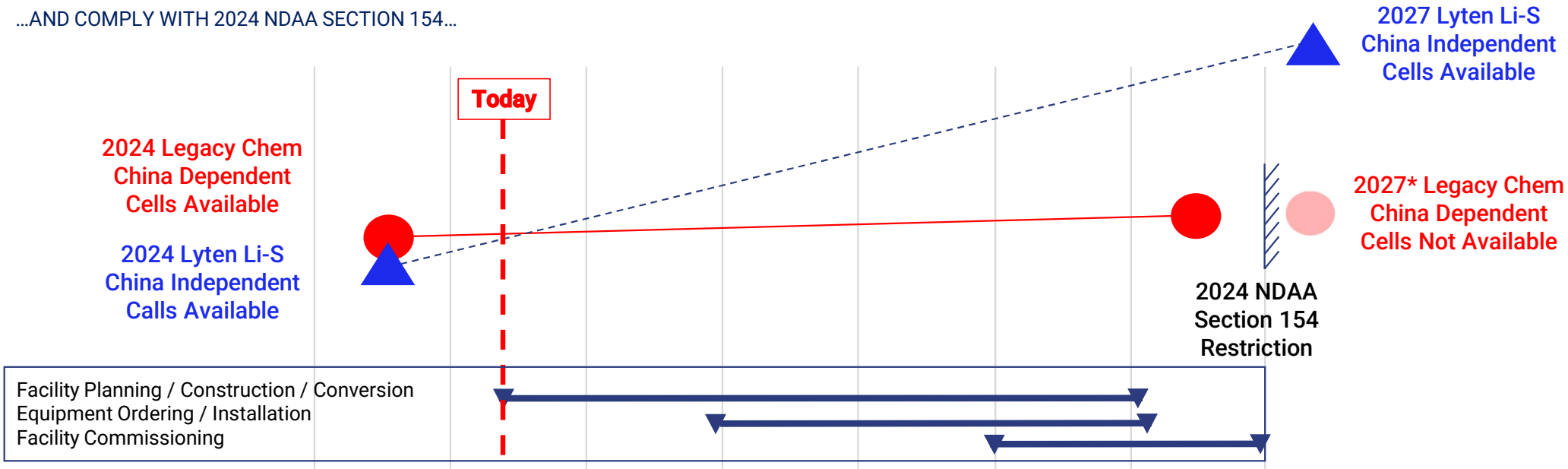


Figure. Cradle-to-gate emissions from 28 battery chemistries analyzed by 10 peer reviewed LCAs (details provided) compare to LCA for Lyten Li-S battery. LCA and comparison study completed by EcoEngineers.

Must Start Now to Break Strategic Dependence on China…

…AND COMPLY WITH 2024 NDAA SECTION 154…



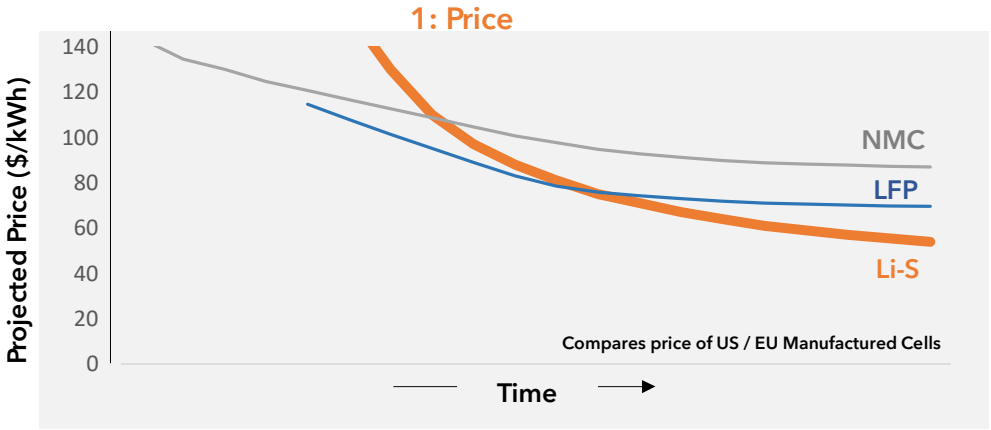
Lyten Cell Performance Comparison - (10x7 Pouch Cell)

	2024/27 Li Ion** (NMC / LFP)	Li-S 1Q24 Spec (bal / hi-e)	Li-S 2Q24 Spec (bal)	Li-S 3Q24 (Projected)	Li-S 4Q24 (Projected)	Li-S 4Q25 (Projected)	Li-S 4Q26 (Projected)	Li-S 4Q27 (Projected)
Energy Density (Wh/kg)	265 / 160	231 / 290	248	325	350	375	400	600
Cycle Life (C/3)	1500 / 2000 (C/2)	123 / 30 (C/3)	230	300	300	400	500	>800

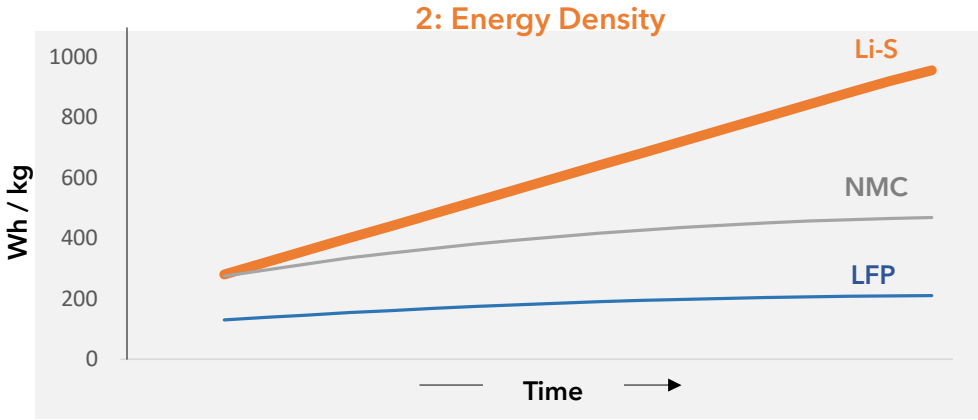
** Or Potentially Earlier, Depending on China's Unilateral Desire*
***Source: 2023 Volta Battery Report (https://volta.foundation/battery-report/)*

Li-S VS NMC (SOLID STATE, Si ANODE) AND LFP

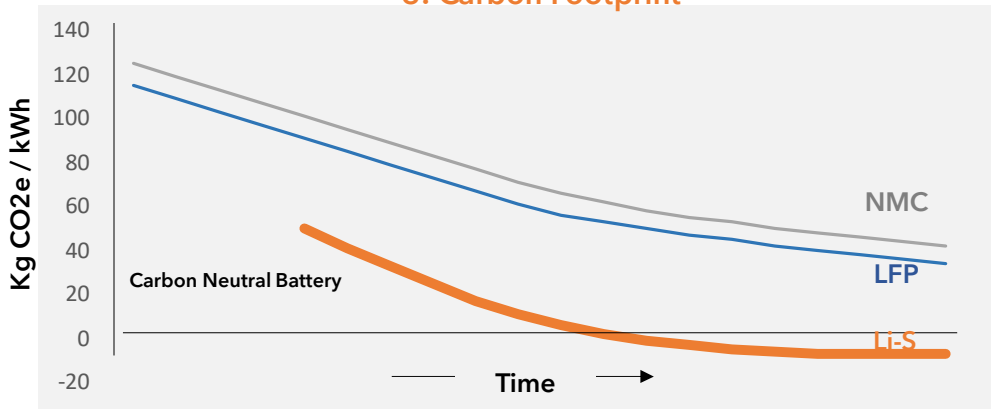
1: Price



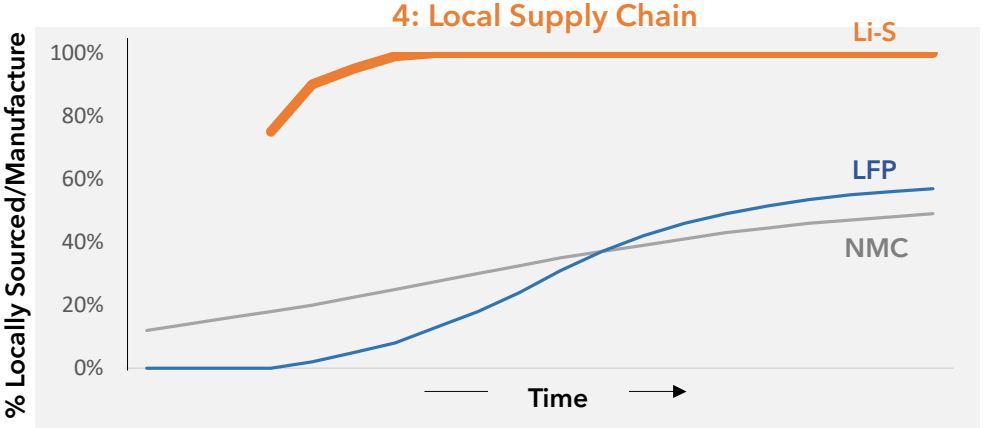
2: Energy Density



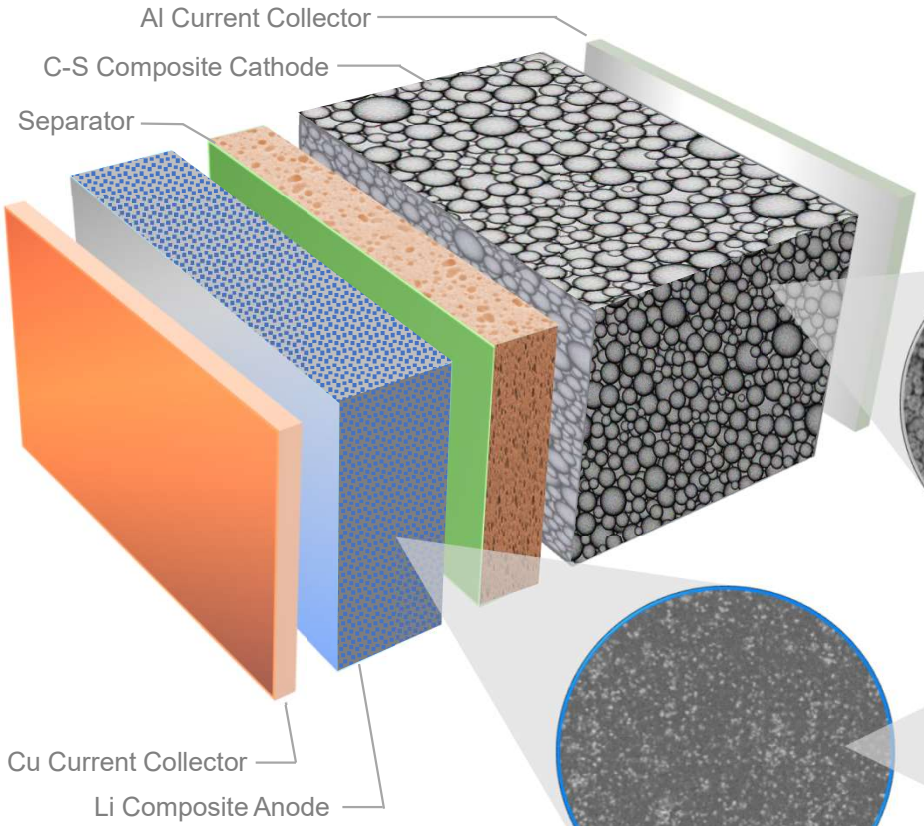
3: Carbon Footprint



4: Local Supply Chain

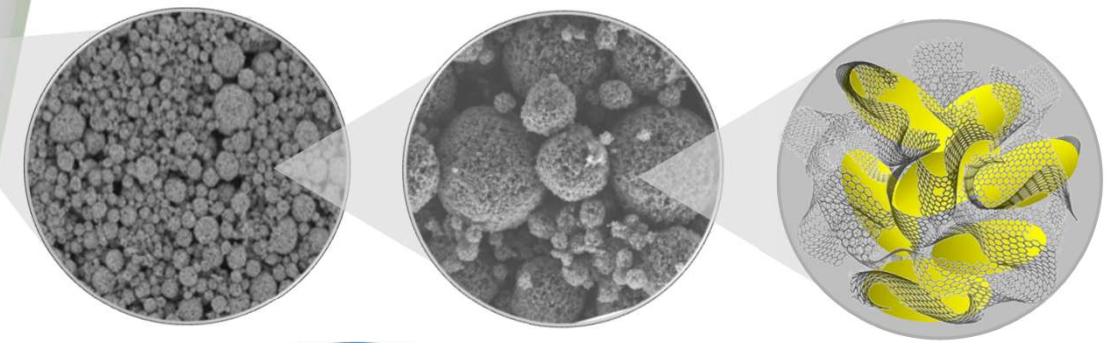


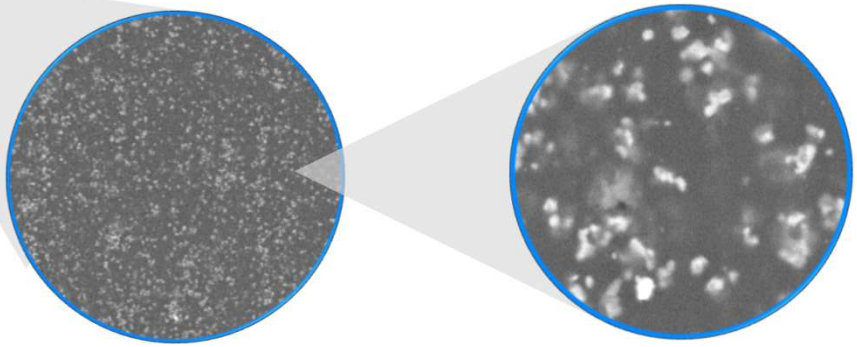
Lyten Lithium Sulfur Cell Architecture



Nanostructured 3D Graphene™ for high sulfur capacity and stability

High conductivity of 3D Graphene™ for high charge/discharge rates



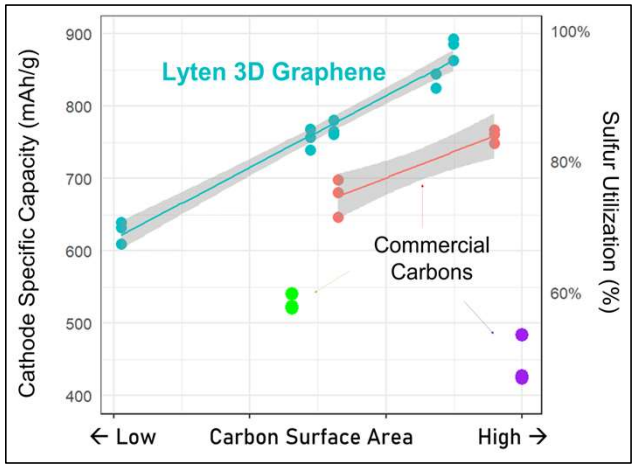


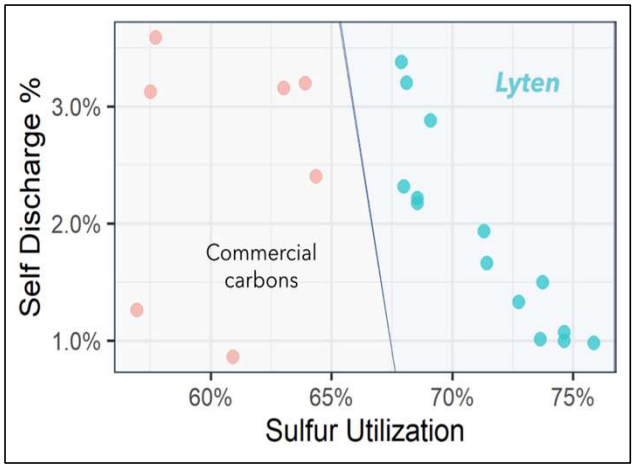
Lithium metal composite anode mitigates anode degradation

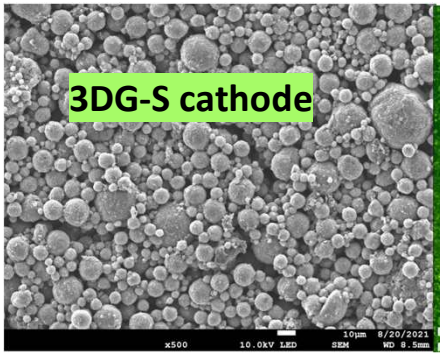
LYTEN 3D GRAPHENE™ SUPERIOR TO COMMERCIAL NANOCARBONS

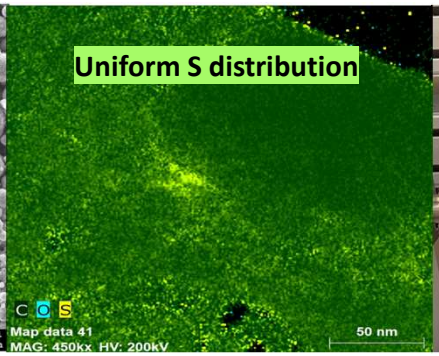
Lyten 3D Graphene forms the primary structure of the cathode

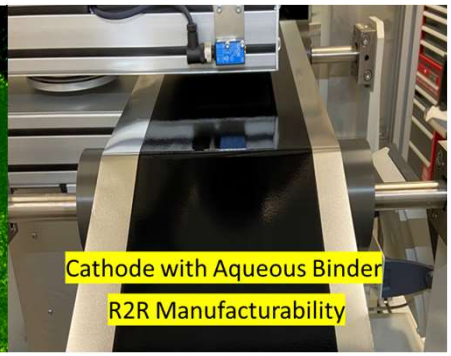
- Chemical environment of 3D graphene may be tuned with aliovalent doping and functionalization to enhance sulfur affinity and kinetics
- Outperforms high surface area commercial carbons. Unique core-shell structure, coupled with high surface-area, results in excellent utilization and low self-discharge.
- Cathodes fabricated with spray-dried active materials with aqueous binder using standard coaters



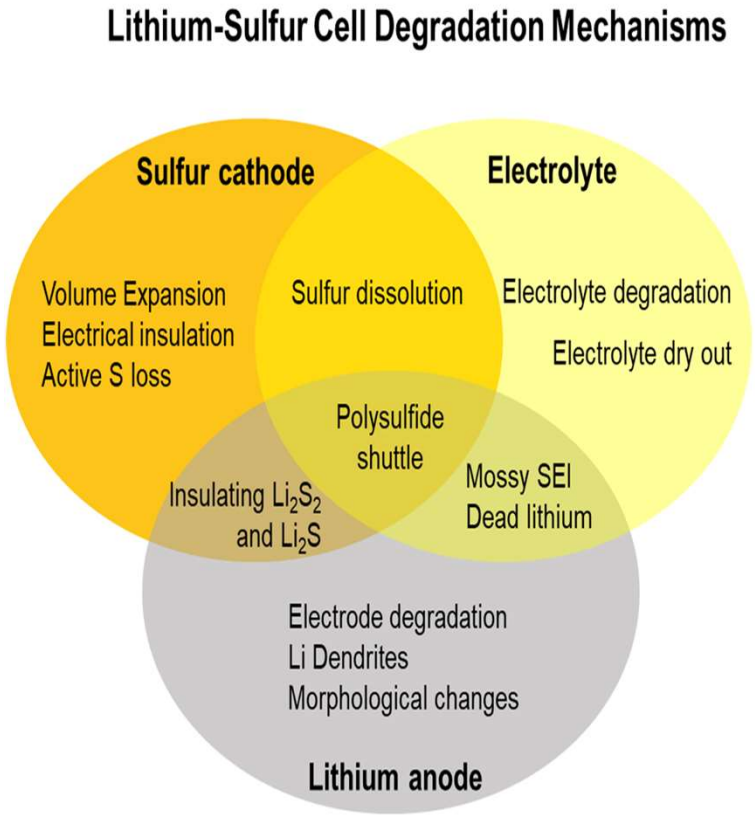








LYTEN ADOPTS A MULTI-PRONGED APPROACH

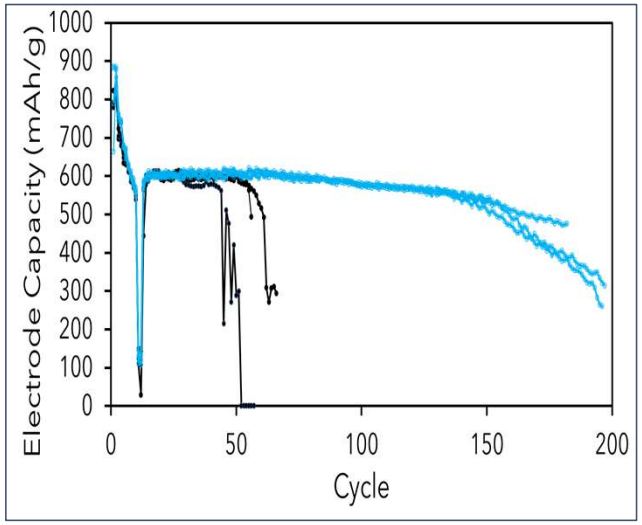


Lyten Solutions

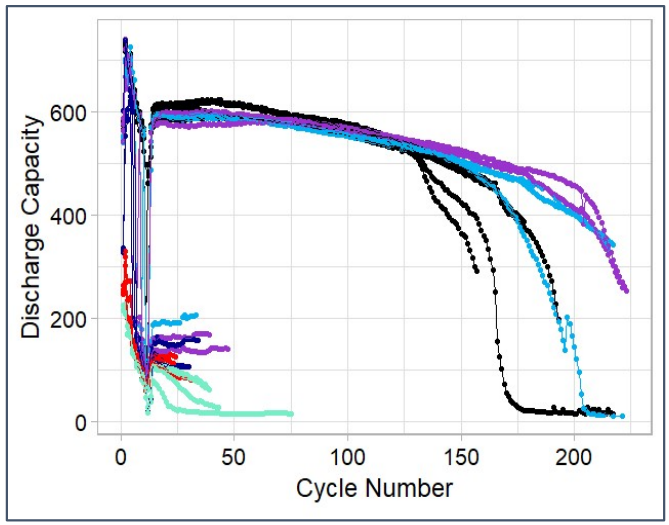
- 3D Graphene Tuning
- 3DG-S Cathode
- Stabilized Anode (composite)
- Proprietary Electrolyte
- Protective Anode Coatings
- Charging Protocol
- Catalysts
- Customized Separator
- Optimized Cell Design

ELECTROLYTE DEVELOPMENT

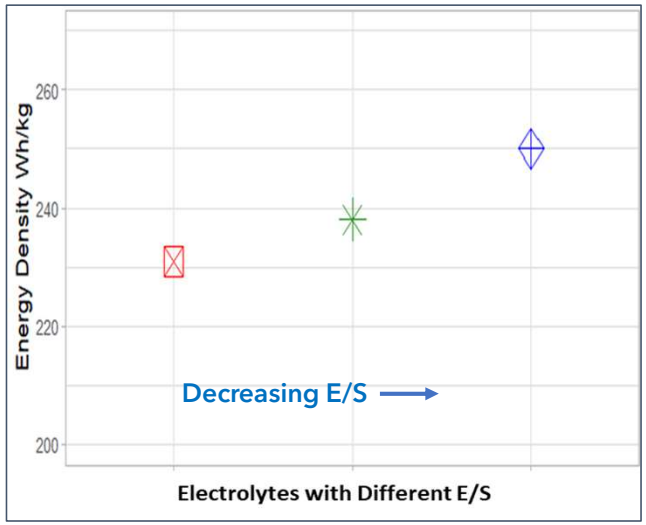
Lyten Electrolyte vs. Literature Standard



Optimization of Salt Content



Low E/S Electrolytes for Higher Wh/Kg

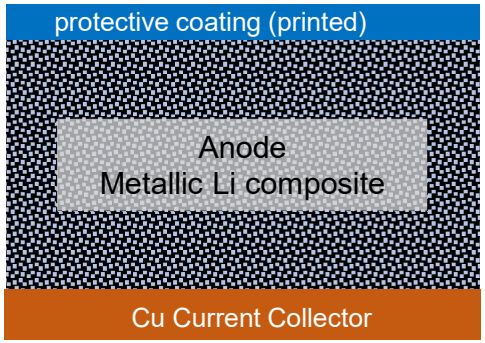


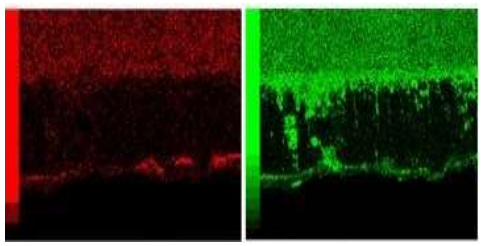
- Trade-off between sulfation kinetics and stability
- Identified family of advanced liquid electrolytes with mixed solvents that significantly outperform the universally used DOL:DME electrolyte, with nearly 4x cycle life.
- Improved performance by optimizing the ratio of solvents and the ratio/concentration of salts.
- Lyten advanced electrolytes enable operation at low E/S and high energy

OPTIMIZATION OF ANODE DESIGN FOR IMPROVED CYCLE LIFE

- New Protective Coatings on Li composite anode

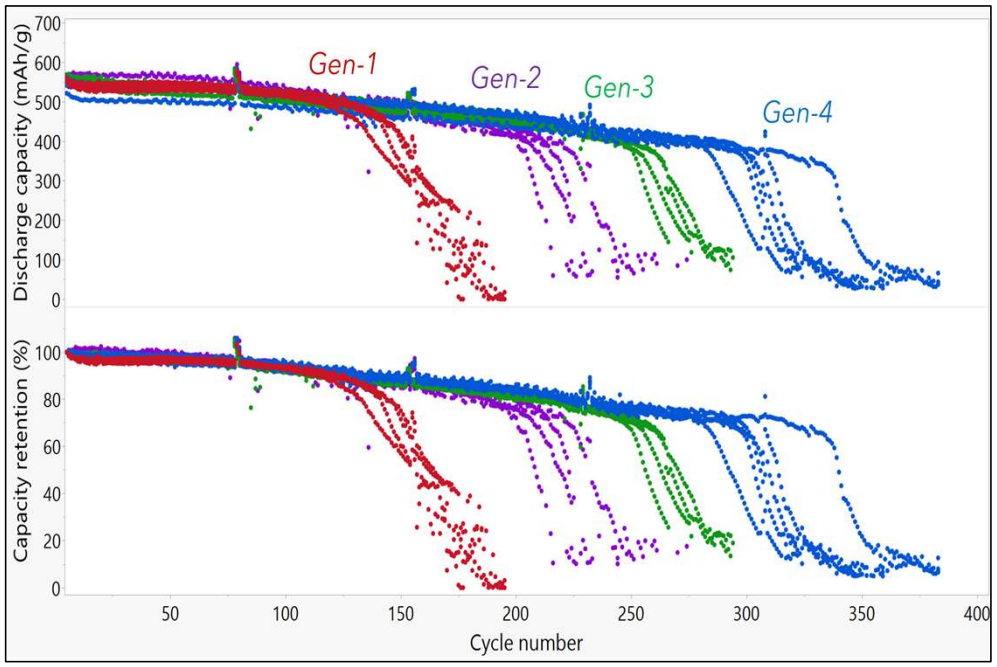
Schematic of Lyten Anode





SEM / EDS of Anode + Coatings

Cycle Life @ C/3,100% DoD with Different Anode Designs



Composite anode with protective coating improves cycle life by 2-3 times vs. Li.

ABUSE TESTING RESULTS – 3rd PARTY

MOBILE POWER SOLUTIONS
Battery Technology Center

MPS Testing

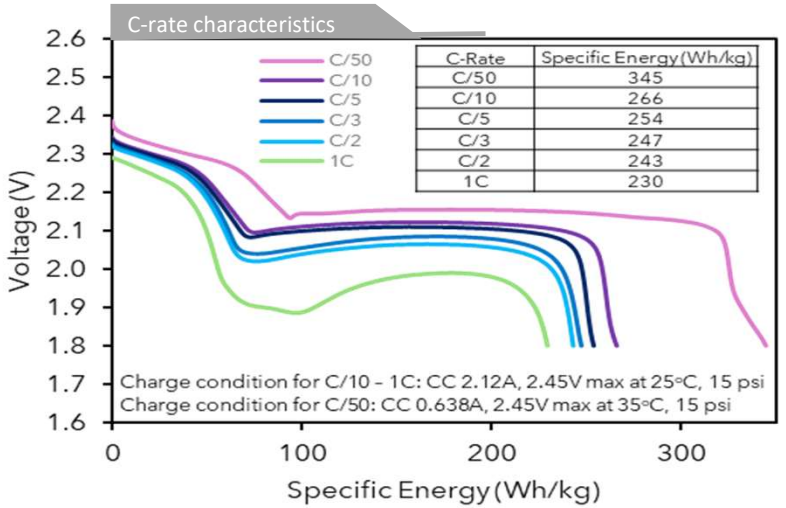
Test	Format	Cell ID	Result
Nail Penetration	Pouch (2.8 Ah)	PP000207	No thermal runaway
		PP000249	No thermal runaway
	18650 (1.6 Ah)	PC000513	No thermal runaway
		PC000511	No thermal runaway
Crush / Impact	Pouch (2.8 Ah)	PP000205	No thermal runaway
		PP000202	No thermal runaway
	18650 (1.6 Ah)	PC000508	No thermal runaway
		PC000517	Thermal Runaway
Overdischarge (150%)	Pouch (2.8 Ah)	PP000201	No thermal runaway
		PP000208	No thermal runaway
	18650 (1.6 Ah)	PC000505	No thermal runaway
		PC000506	No thermal runaway
Overcharge	Pouch (2.8 Ah)	PP000204	No thermal runaway
		PP000224	No thermal runaway
	18650 (1.6 Ah)	PC000503	No thermal runaway
		PC000504	No thermal runaway
Short-circuit	Pouch (2.8 Ah)	PP000203	No thermal runaway
		PP000210	No thermal runaway
	18650 (1.6 Ah)	PC000509	No thermal runaway
		PC000510	No thermal runaway

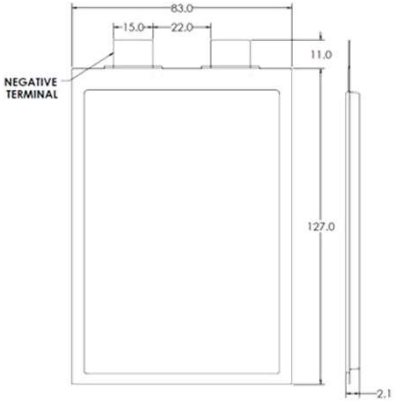
Shipping Commercial Li-S A-Samples: Product Specification

- Shipping cells to automotive OEMs, including Stellantis and other leading US and EU auto OEMs
  - Capable of up to 345 Wh/kg at C/50, 35°C
  - 93% Available energy at 1C relative to C/3

Specifications	
Nominal Capacity	6.55 Ah
Specific Energy	248 Wh/kg
Energy Density	300 Wh/L
Nominal Voltage	2.1 V
Mass	57.2 g
Cycle Life (100% DOD)	230 min. @ 60% Capacity
Max Continuous Discharge	6A @ 1C
Peak Discharge 10s	24A @ 4C (0 – 100% SOC)
DCIR @ 100% SOC, 1C, 10s	1.8 mΩ
Operating Temperature	Charge: 10°C to TBD Discharge: -35°C to 45°C Storage: -35°C to 45°C
Cell Breathing	3 – 5% typical, TBD

*All values are typical and determined at 25°C, C/D @ C/3 (2.12A), 15 psi

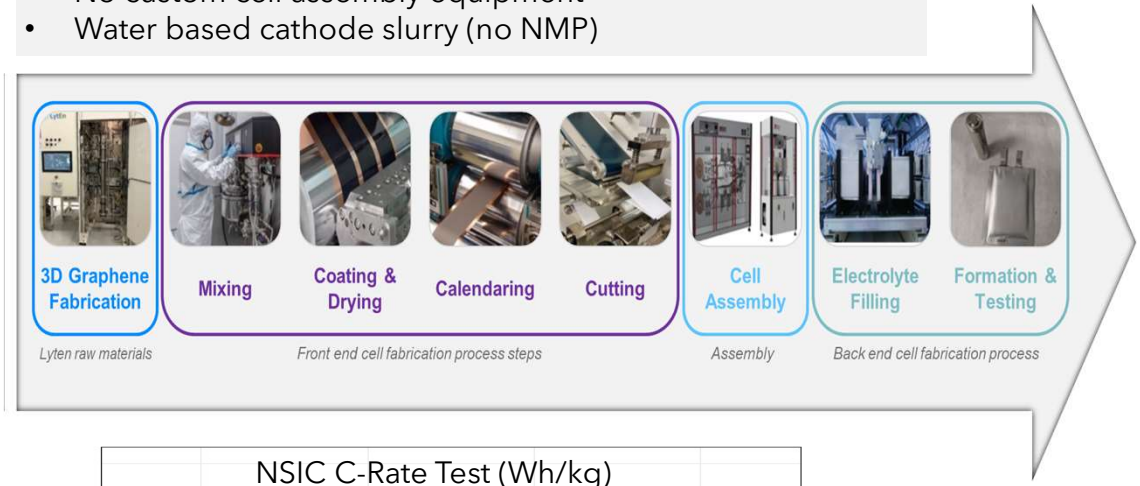


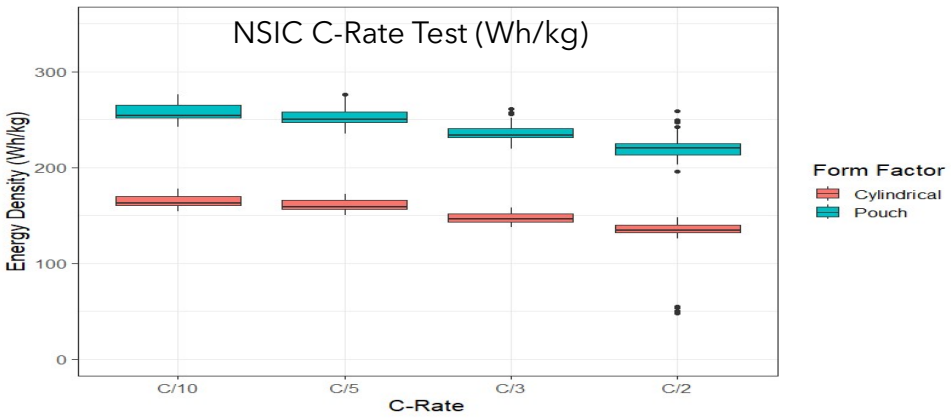


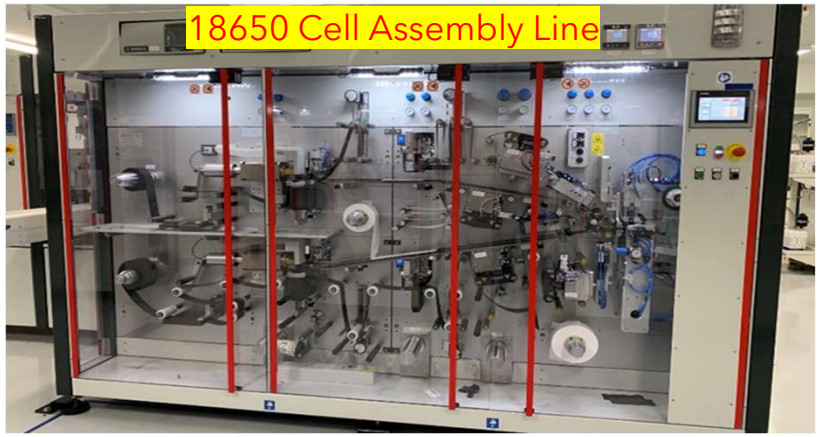
San Jose Lithium-Sulfur Cell Pilot Line

LYTEN LI-S CELLS USE STANDARD PRODUCTION EQUIPMENT

- Semi-automated cell pilot line in dry-room (2MW capable)
- No custom cell assembly equipment
- Water based cathode slurry (no NMP)





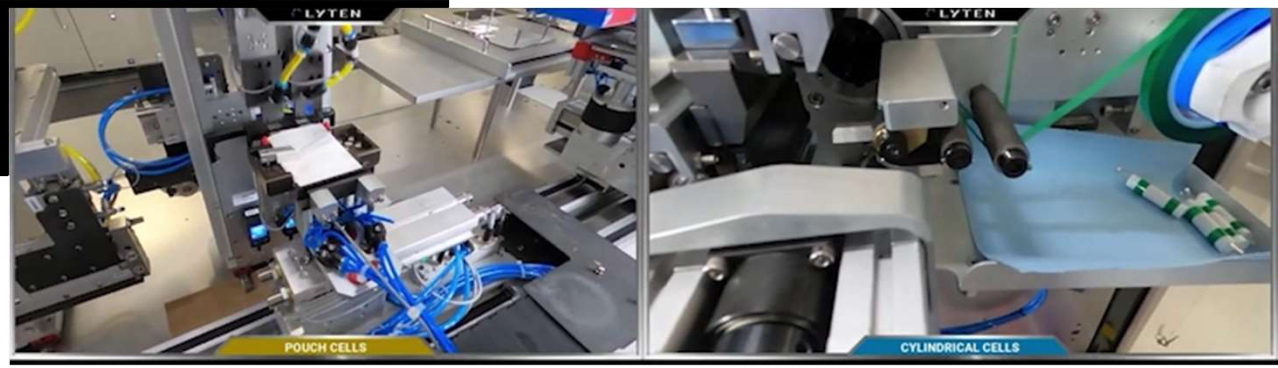


Hi **Recent DIU(NSIC) Milestone : production of 50 pouch + 50 cylindrical cells in a single shift**

SAN JOSE PILOT LINE

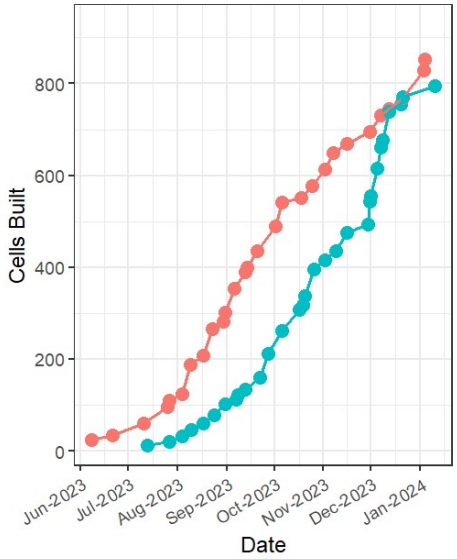
Commercial LIB production line
With only minor modifications

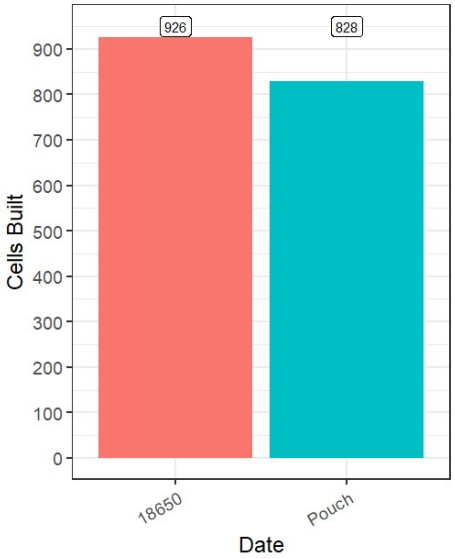
Ramping to 200,000+ cells per year
2MWh nameplate capacity

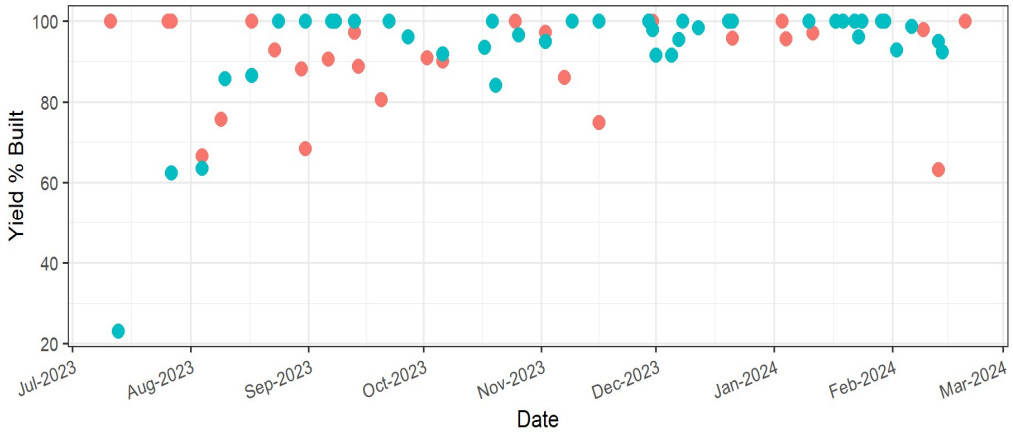


PILOT LINE YIELD AND PRODUCTION NUMBERS

Yield >90%







STELLANTIS ANNOUNCES PLANS TO MAKE EV'S 50% LIGHTER

"Lyten's lithium-sulfur battery has the potential to be a key ingredient in enabling mass-market EV adoption globally"

Carlos Tavares, Stellantis CEO

Lithium-Sulfur (Li-S) BB-2590 Battery

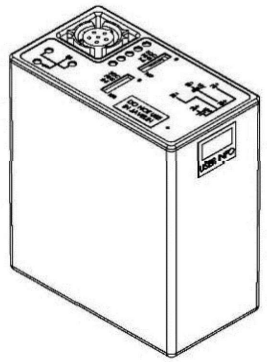
Parameter	Requirement	Projected Li-S Performance (Based on 2024 Target)
Voltage		
24V Mode (12S1P):	20 – 33.6 V	21.6 – 29.4 V
12V Mode (6S2P):	10 – 16.8 V	10.8 – 14.7 V
Current		
24V Mode:	10 A (cont.) 36 A (pulse)	18.2 A (cont.) 36.4 A (pulse)
12V Mode:		36.4 A (cont.) 72.8 A (pulse)
Energy	275 Wh	232 Wh
Power	280 W	464 W
Cycle Life	224 cycles (<C/4.5)	300 cycles (C/3)
Operating Temperature	-30 to 55 °C	-30 to 55 °C
Weight	3.25 lb.	2.33 lb. Weight savings of 0.92 lb. or a 28%
Safety		Lithium-Sulfur cells are generally expected to be safer than Li-Ion cells due to its conversion chemistry

Notes: Battery: 5.0” x 4.4” x 2.5” and Proposed Cell: 4.16” x 3.32” x 0.18”.

Lyten’s Pouch Cell Performance Road Map

Parameter	2024 Target	2026 Target	2028 Target
Specific Energy (Wh/kg):	350	400	600
Energy Density (Wh/L):	475	600	800
Cycles [EoL 70%] (C/3):	300	500	800

Lyten’s next generation Li-S system will outperform the Li-Ion chemistries and provide the warfighter with 28% lighter weight batteries and enhanced safety.



BB-2590 Battery

The weight advantage of the Li-S chemistry means that man portable equipment will be easier to transport due to its lower weight.

LI-S VALUE PROPOSITIONS

Lowest $/Wh	Replacing Ni-based cathodes with Sulfur is projected to lower raw material BOM cost by >50%
High Specific Energy (Wh/kg)	>2x practical specific energy compared to existing technologies
Abundant and Accessible Raw Materials	Sulfur is abundant in high quantities as a byproduct of minerals and petrochemical production – eliminates world reliance on scarce Ni resources
Reliable North America Raw Material Supply	Target 100% sourced and manufactured in NA: Lyten could help OEMs meet 2025 USMCA mandates
Decarbonization Material Platform	Target: 60%+ lower cell material emissions – eliminate conventional cathode active material production, eliminate conventional graphite processing, generate graphene and H_2 from light hydrocarbons
Safety	Strong resistance to overcharge, metal contamination, and puncture failure modes
Minimal Technology Switching Costs	Lower greenfield capex and minimal incremental brownfield conversion capex due to a simpler manufacturing process and Li-ion B facility compatibility

LYTEN