

# NAATBatt Annual Conference 2025

## *Extending Range*

Chief Technology Officer Report  
2/18/2025

Brian Engle for Bob Galyen

NAATBATT 2025

EXTENDING RANGE

# Bob's 5 Golden Rules of Electrification: A Philosophy to Live By



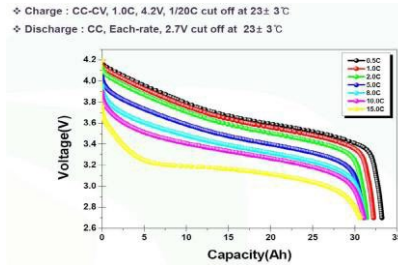
**Safety**



**Performance**



**Life**



**Cost**



**Environmental**



# 2024 Announcements



**General Motors** to retire "Ultium" branding, expands NMC pouch cells to include LFP and prismatic formats.



**Tesla** plans 4 new batteries in 2026, including batteries for its robotaxis.

**Cirba Solutions** and **EcoPro** sign MOU to produce pCAM and CAM in North America.



**South Korea** plans \$7B push to pivot EV battery industry away from China.



**BMW and Redwood Materials** establish partnership to recycle Li-ion batteries in the U.S.A.



**Lyten** begins shipping lithium-sulfur A sample cells to automotive OEMs, including Stellantis and others.

**Lyten** investing more than \$1B to build the world's first Li-S gigafactory in Nevada with up to 10 GWh/yr capacity.

**China** forms Solid State Battery consortium with 200+ members including CATL, BYD, CALB, EVE Energy, Gotion, government agencies, universities, research institutes, and capital partners to drive commercialization of SSBs by 2030.



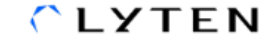
**US DOE** to award \$3B to 25 projects for battery manufacturing sector including Group14, South32, Mitra Chem, and Form Energy.



**LG Chem** signs \$19B cathode supply agreement with GM.



**Stellantis and CATL** to invest \$4.3B to build an LFP plant in Spain with production.



**Hyundai** announces the production of solid state batteries by the end of 2025 and is planning mass production by 2030.



**BYD** launched ultra low-cost (\$9.7k) EV powered by 30 kWh of LFP Blade batteries.

**BMW** cancels \$2B battery cells contract with **Northvolt**.

**Natron Energy** announces \$1.4B gigafactory in North Carolina.



**China** plans \$845MM investment to develop SSBs in a government-led project.

**CATL** unveils Shengxing PLUS LFP battery at 205 Wh/kg, capable of charging at 4C with "1,000 km range".



**Mercedes-Benz Korea** reveals issues with batteries supplied by Farasis following EV fire incident.

**BYD** launches sodium-ion BESS battery based on the company's Long Blade Battery technology.

**Ion Storage Systems** commissions one of the largest SSB manufacturing facilities in the United States.



**Factorial and LG Chem** sign MOU to develop SSBs.



**CATL** launches new Tianxing battery with 1 million mile warranty and 15-year service life.



**Honda** opens a demonstration plant for its proprietary solid state battery technology.



**Battery technology continues to evolve with longer life, new chemistries, solids state, lower cost variants**  
**Advances in materials and recycling**  
**Transparency/visibility of safety incidents; improved safety tec**

## 1 INDUSTRY | OVERVIEW



### Industry Summary

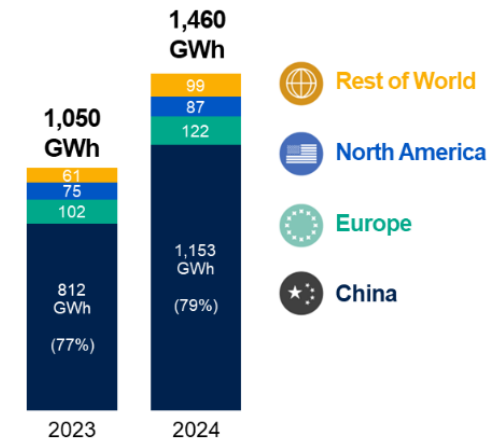
2024 marked a year of continued growth and adaptation in the global battery industry. Global xEV sales climbed 25% to 17.7M units, with BEV demand up 14% while PHEV demand surged 50%. For the first time, BEVs in China have reached price parity with fossil vehicles. This milestone comes as China continues to lead the world in EV market penetration, with xEVs accounting for 45% of new car sales. Automakers globally are adapting their strategy, with Chinese automakers expanding into Europe and the Global South, while some traditional OEMs cut back on EV targets and investments. The 'BESS Decade' continues to gain momentum with 55% year-on-year growth. Battery Energy Storage Systems (BESS) now account for 15% of total battery deployments, up from 7% in 2020, highlighting its rapid adoption. New BESS installations in 2024 alone contributed over 45% of the current cumulative global capacity of 150 GW / 363 GWh, underscoring BESS's significance as one of the most promising and fast-growing sectors in the battery industry landscape.

Battery prices at the pack level saw the largest drop since 2017, improving 20% from 2023 to a record low of \$115/kWh. Global battery manufacturing capacity increased from 1.05 TWh to 1.45 TWh in 2024. Overcapacity across the battery supply chain drove cell prices to the unsustainably low level of \$50/kWh for China-made LFP cells, resulting in involuntary competition and investment pullback. New Chinese industrial policy aimed at phasing out low-quality capacity added further pressure. For battery producers navigating this challenging pricing environment, current strategic focus include cost reduction, technological innovation, vertical integration, and diversification into overseas markets in search of higher profit margins. China continues to dominate the supply chain, owning >80% of key cell components and cells.

The battery investment landscape in 2024 slowed, with fewer VC/PE deals due to higher interest rates and geopolitical tensions. While growth was supported by significant debt raises and government funding—such as Northvolt ETT AB's €5 billion green offering and the US DOE's \$9.6 billion loan to BlueOval SK—the bankruptcy of Northvolt highlighted risks in the sector, dampening investor confidence. Public market performance was mixed, with established battery OEMs benefiting from new product launches, while shares in EV startups, charging infrastructure, and lithium companies underperformed. The US DOE supported the sector by investing over \$3 billion into 25 projects to bolster domestic battery production and supply chains in the United States.

Emerging technology trends in 2024 include the introduction of medium-nickel high-voltage NMC and high-compact-density LFP cathodes. Significant strides were made in the commercialization of dry electrode processing, LxFP, engineered silicon, and pre-lithiated anodes, all aimed at improving energy density, cost, and safety. Alternative cell chemistries, such as Na-ion, solid-state batteries (SSB), sulfur, and Li-metal, also progressed toward commercialization. Notably, sodium-ion and semi-solid state products, primarily developed by Chinese manufacturers, are now being integrated into commercial EVs and BESS systems.

Novel use cases such as EVTOL, marine, and data centers are achieving higher levels of technical readiness. Notably, artificial intelligence (AI) is quickly being deployed across the entire value chain from materials discovery to fleet data analytics to accelerate the advancement of these technologies and is emerging as a new focus for commercial R&D and entrepreneurial energy in the space.



IN 2024, GLOBAL LITHIUM-ION BATTERY CELL PRODUCTION REACHED ALMOST

# 1.5 TWh

## 59% were LFP batteries

## 4/5 were EV batteries

## 4/5 were made in China

- **Global production capacity ~1.5 TWh**
- **EV's reach price parity in China**
- **Pack prices drop 20% to \$115/kWh; cell prices drop to \$50/kWh**
- **BESS @ 55% YoY Growth; 15% of total battery deployments @ 150GW**
- **Northvolt bankruptcy; new market growth in EVTOL, marine, datacenters**



## Fire Events & Response

Fire events underscore the importance of multi-front approaches in lowering the failure incidence rate of battery products. These include validating propagation-resilient designs, proactive measures in quality, working standards, handling, storage, emergency response, and safe disposal of EOL lithium-ion batteries to mitigate fire risks.

### PUBLIC EVENT EXAMPLES & RESPONSES

**Otay Mesa, California, USA:** A fire erupted at the Gateway Energy Storage facility. The fire persisted over several days, with batteries reigniting multiple times. Firefighters implemented evacuation orders and worked to contain the blaze.

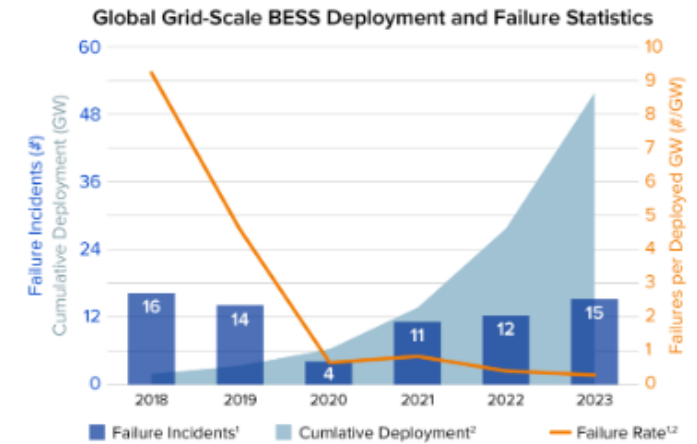
**Fuzhou, Fujian, China:** A fire burned down in a BYD dealership, marking the tenth BYD incident since 2021. BYD conducted an inspection, stating no abnormalities were found in the vehicle batteries and denying that the fire originated from its vehicles.

**Hwaseong, Gyeonggi, South Korea:** A series of explosions at a lithium battery factory owned by Aricell resulted in a massive fire, killing 23 workers and injuring eight. Approximately 145 personnel and 50 units of firefighting equipment were deployed, extinguishing the fire after about five hours. Subsequently, three company officials were investigated for violating industrial safety laws, and the CEO was arrested.

**San Pedro, California, USA:** A big rig carrying lithium-ion batteries overturned near the Port of Los Angeles, causing a fire that burned for days. Firefighters allowed the fire to deplete its combustible material and burn out. The incident led to the closure of the Vincent Thomas Bridge and several port terminals, disrupting operations.

**Florida, USA:** 16 lithium-ion battery fires, including six EVs, caused by exposure to saltwater storm surge during Hurricane Helene. Residents were advised to unplug and relocate damaged devices to open spaces, and agencies coordinated safe disposal measures. EV manufacturers were urged to provide guidance for storm-prone areas.

**Fredericktown, Missouri, USA:** A massive fire erupted at the Critical Mineral Recovery facility, a lithium-ion battery recycling plant, releasing thick, toxic smoke. Authorities ordered evacuations and shelter in place orders for residents. The Missouri Department of Natural Resources assessed potential environmental impacts.



Sources: (1) EPRI Failure Incident Database, (2) Wood Mackenzie. Data as of 12/31/23.

**Data from EPRI** suggests failure rates of BESS **have decreased** as more battery systems have been deployed.

- **Despite growth in installed capacity, significant reduction in incident levels**
- **“Blind spots” in safety include EOL/DDR transport and storage**
- **Extraordinary events including flooding and forest fires have become a challenge for damaged battery systems**

Every step in battery production presents challenges, but some, like **coating, drying, and slitting** carry a significantly higher risk of defects. The **heat map** illustrates these critical areas, highlighting their **likelihood of defects**.

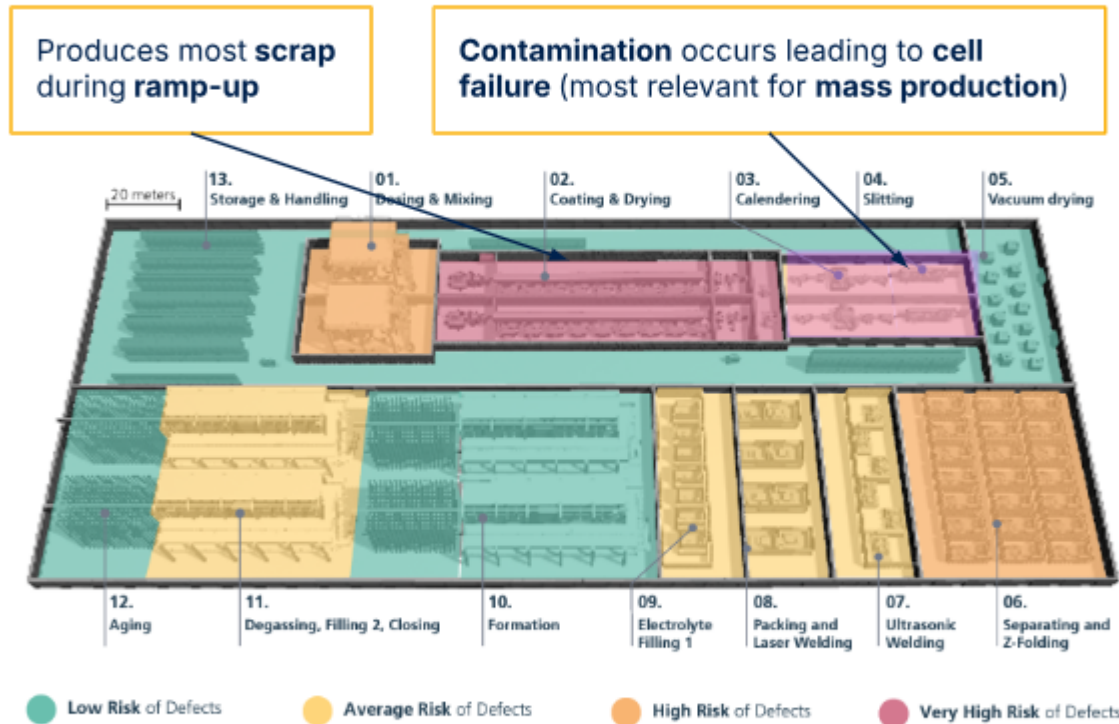
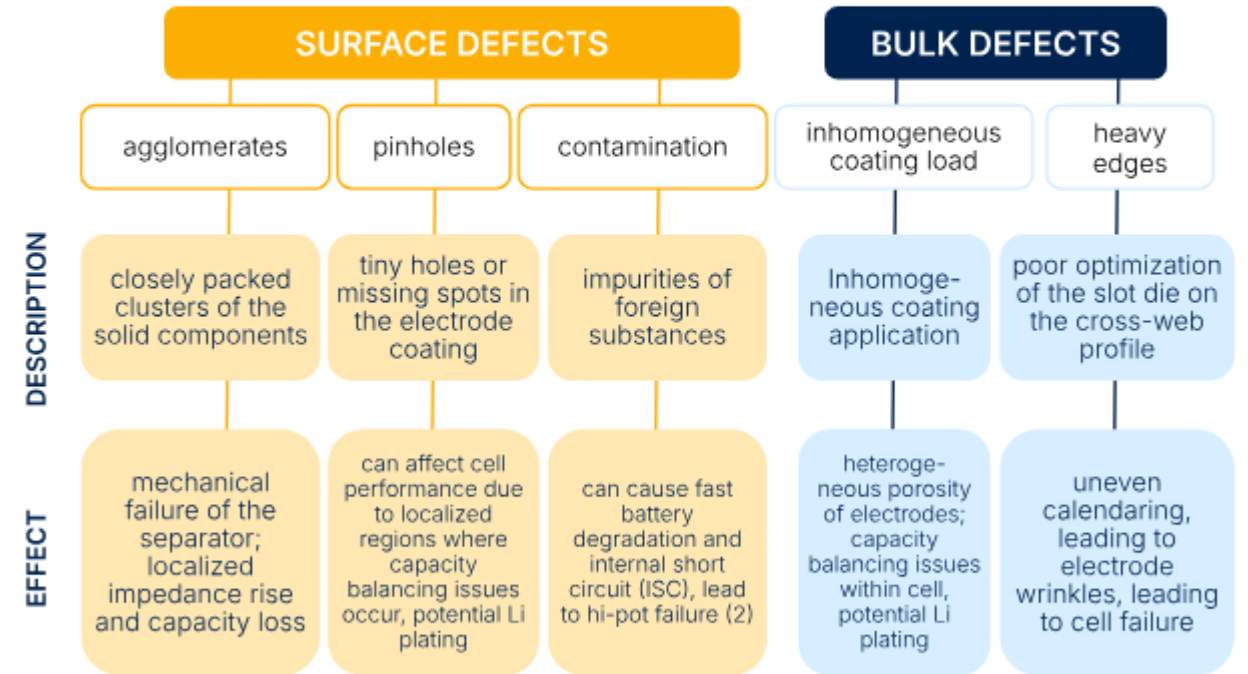


Figure 6 Layout of a typical, modular battery cell production line (7-10 GWh/a) and their risk level for defects. A battery cell factory has multiple of such modules/lines.

## MAJOR DEFECTS THAT CAN OCCUR DURING COATING AND DRYING OF ELECTRODES



Sources: [Mastering Ramp-up of Battery Production](#), Fraunhofer (Both Figures but with internal edits\*); (2) High-Potential Failure Analysis, Sotto; Detecting the foreign matter defect in lithium-ion batteries[...], Pan et al.

**Manufacturing profitability is significantly affected by yields in electrode processing – incremental improvements still needed**  
**PPB-level quality absolutely necessary**

- ***More attention paid to Safety, BMS system design*** (most patented area)
- Scaling / Prototyping (Manufacturing) remain as the most critical problem in North America and Europe
- Academic research and industry R&D increase in Na and Zn electrochemistries
- Growth in education program throughout the R1 universities is promising, however lacks in community colleges (oversupply of R&D personnel and lack of manufacturing personnel)



Shirley Meng, chief scientist at Argonne National Laboratory



Dry Battery Electrode (DBE) Processing

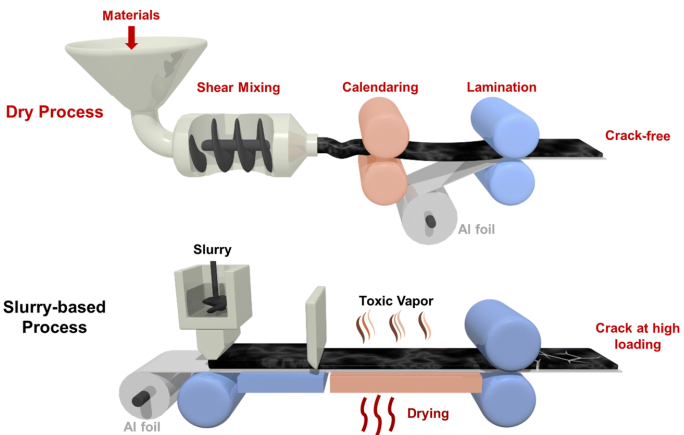
Single Crystal NMC/NCA

Electrolyte Genome

Anode-Free

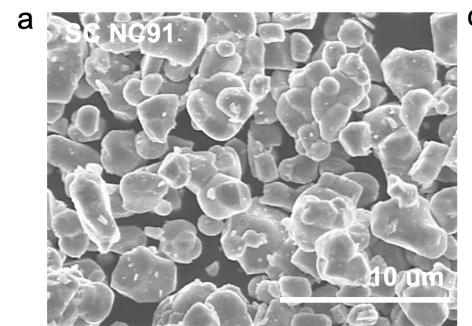
All Dry 4680 in Cybertruck 2024

Many New Players in the Field



Better Cost Performance Ratio

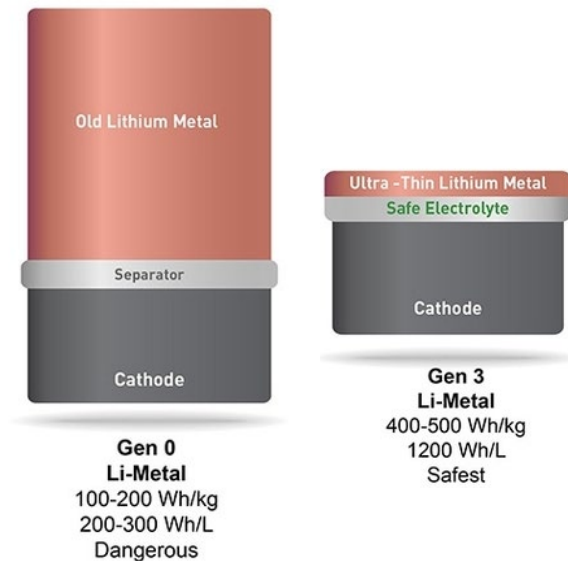
Allowing Ultra-long life



-60 to +60 C  
Wider operation temperatures  
Enabling Thick Electrode/  
New Chemistry



Projected Energy Density  
Over 500 Wh/Kg

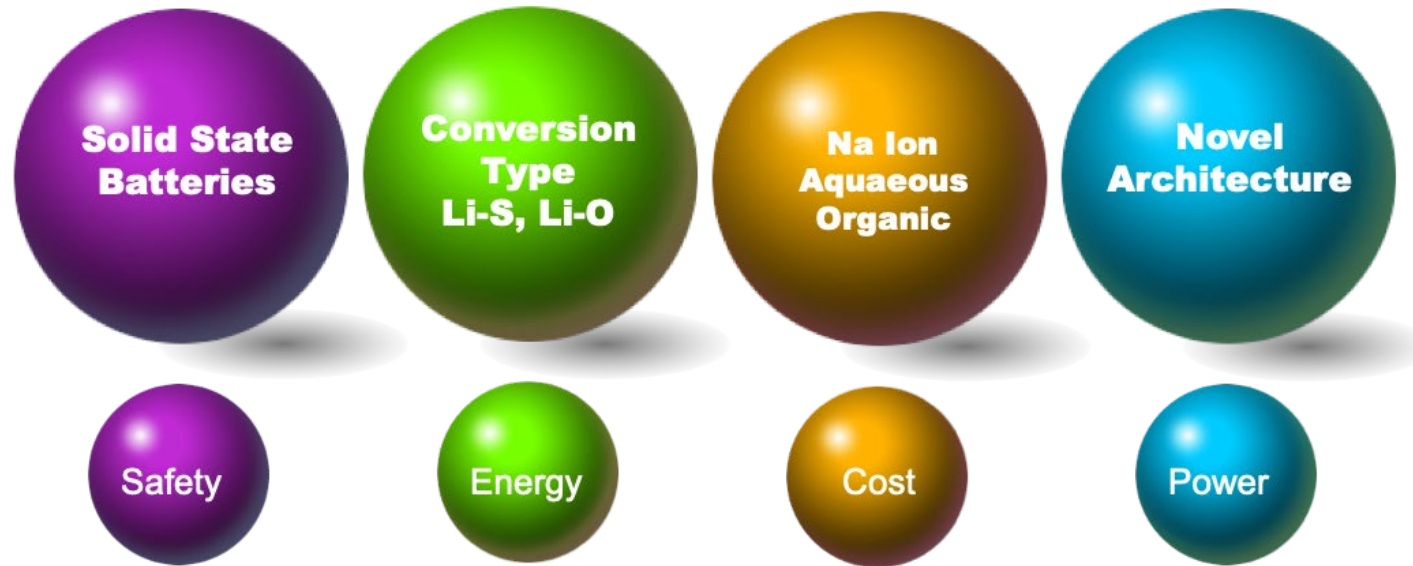




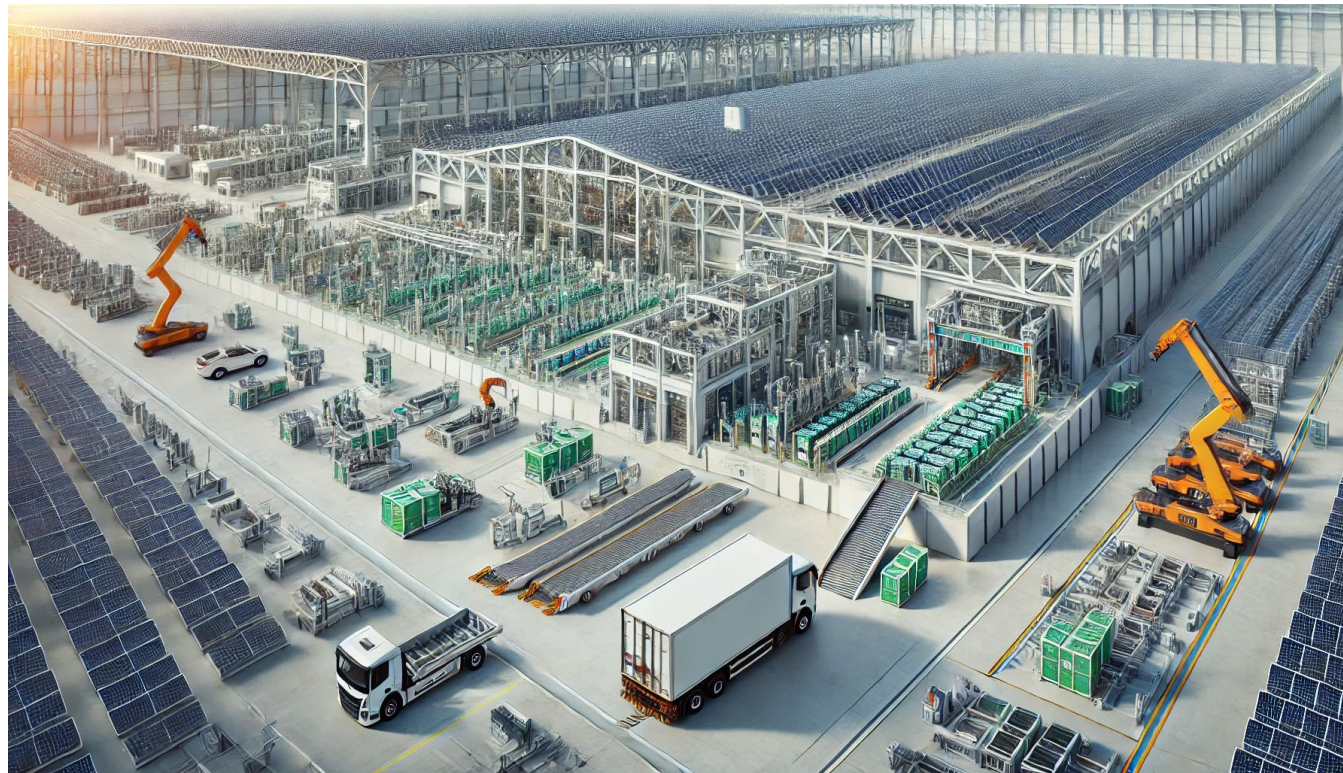
# Beyond Li Ion Battery – Exciting Progresses are Made



- Sodium Ion Battery >100MWh Prototyping is Done – Planning for Giga-Scale
- All Solid-State NMC/Anode free is Moving towards Prototyping
- Zn Aqueous Battery is Moving towards Scaling to MWh
- All Solid-State Li-S Battery Demonstrated by Several Research Groups
- Anode free Sodium All Solid-State concept is realized and demonstrated



## 1 – Regional Gigafactory Expansion

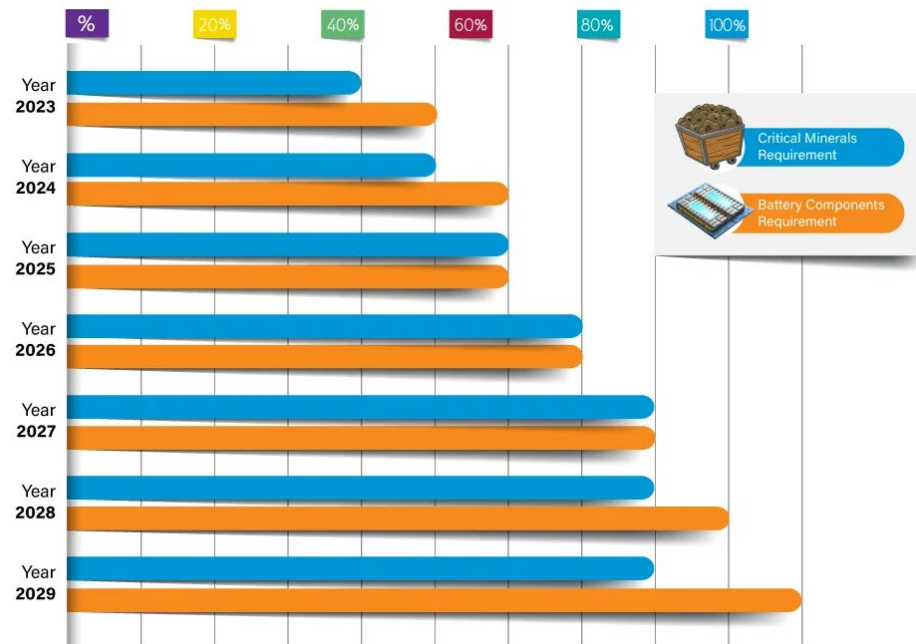


### DEVELOPMENTS:

- Tesla, LG, GM, and Panasonic expanding U.S. and Canadian factories, driven by IRA incentives.
- Lyten's Lithium-Sulfur Battery Gigafactory in Nevada
- *Policy and market growth driving localization of production and supply chains*
- *“Overcapacity bubble” depressing pricing and challenging appetite for investment*
- *“Right size” investment and expansion to match demand in region*

## 2 - IRA Incentives Impact

### Inflation Reduction Act of 2022 (US)



### KEY DEVELOPMENTS:

- Strict U.S. Treasury sourcing rules on battery materials for EV tax credits.
- Clean Electricity Production Tax Credits Finalized
- Inclusion of Mining Companies in Clean Energy Manufacturing Subsidies
- **Examples include Forge Battery, \$100M BIL winner for cell production and other NAATBatt members**
- **Policymaking dynamics creating uncertainty in future investment reviews**
- **Markets and many business plans already accounting for decreased federal support**
- **Batteries must stand on performance and ownership cost benefits**



## 3 - Localized Supply Chains

### KEY DEVELOPMENTS:

- Canada/U.S. expanding lithium refining, graphite, and nickel projects.
- First N. American Cobalt Refinery goes live - Electra Battery Materials began refining cobalt sulfate in Ontario
- ***Dynamic policy / tariff environment creates obstacles and opportunities***
- ***New regional material sources also need permitting, refining support***
- ***Resourcing material supply chain is highly complex, costly, and time-intensive***





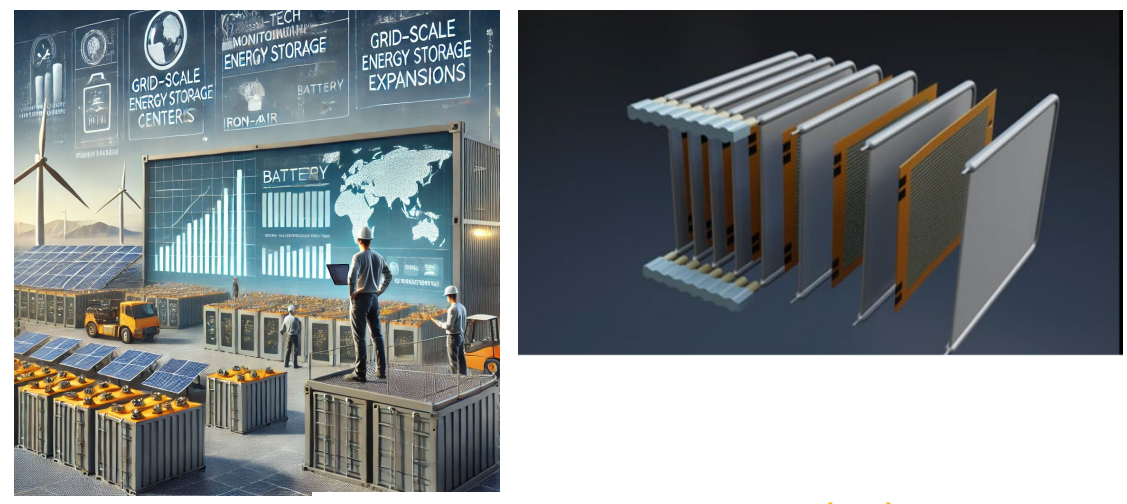
## 4 - Battery Recycling Growth

### KEY DEVELOPMENTS:

- Federal Investments Bolstering Domestic Battery Recycling
- Strategic Partnerships Enhancing Recycling Capabilities
- Market Growth Amidst Economic Challenges
- Baseload battery recycling is manufacturing yield loss
- ***Recent events (Pallisades fire, Moss Landing, etc) creating a short term boost in material to be recycled***
- ***Projections for battery life continuing to increase***
- ***Recoverable material market for certain chemistries makes recycling a challenge***



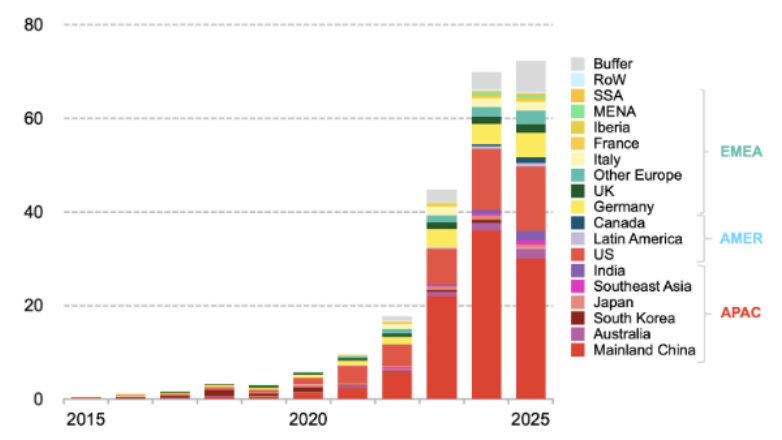
## 5 - Energy Storage Advances & Controls



### KEY DEVELOPMENTS:

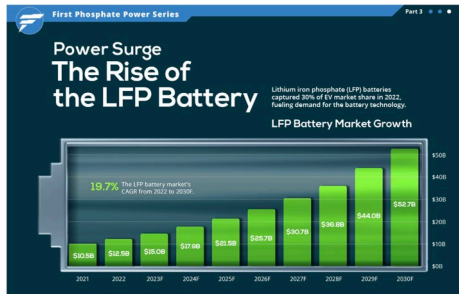
- Record Expansion of Battery Storage Capacity
- Major Investments by Energy Companies
- Strategic Policy Initiatives
- **New sensors and controls enabling improves BMS (Flexoo example)**
- **AI and grid demands creating unprecedented opportunity for BESS growth**
- **LFP Chemistries majority, also include flow, sodium-ion**
- **Virtual Power Plants**
- **AI/Machine-Learning improving performance**
- **Dielectric coolants**

GLOBAL ADDITIONS BESS POWER (GW)





## 6 – LFP, Sodium-Ion, and Solid State Growth



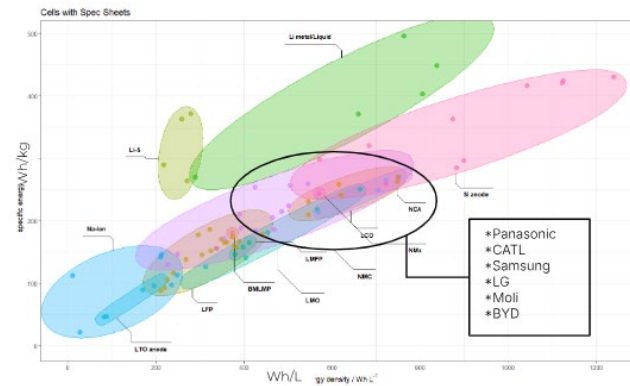
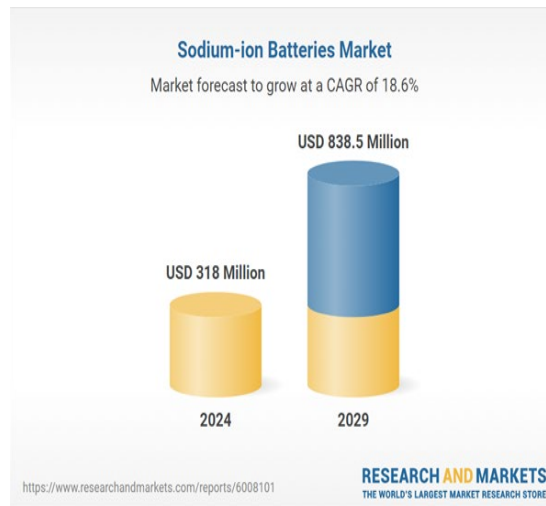
SOURCE: <https://evboosters.com/ev-charging-news/lfp-batteries-transforming-ev-market-dynamics-globally/>

Applications Matched to Preferred Performance Metrics	Market Size and Priority					Lithium Ion												
	2024 Market \$B USD	Priority #1	Priority #2	Priority #3	Priority #4	High Voltage V/L	SEC	NCA	LFP	LMFP	LMO	High Voltage Heavy Duty	Highly Linear	Highly Linear Metal	Highly Linear Metal	Highly Linear Metal	Highly Linear Metal	Highly Linear Metal
Planes	428.42	Safety	Wh/kg	Power	Reliability	Poor	Low	Low	Poor	Poor	Poor	Poor	Good	Poor	Low	++Good	++Good	++Good
eVTOL	11.90	Power	Wh/kg	Safety	Reliability	Poor	Low	Low	Poor	Poor	Poor	Poor	Good	Poor	Low	++Good	++Good	++Good
Aerospace	12.90	Power	Wh/kg	Safety	Reliability	Poor	Low	Low	Poor	Poor	Poor	Poor	Good	Poor	Low	++Good	++Good	++Good
Low Earth Orbit Satellites	42.44	Cycle Life	Wh/kg	Reliability	Safety	Ang	Ang	Ang	Ang	Low	Poor	Poor	Ang	Ang	Ang	++Ang	++Ang	++Ang
Medium Earth Orbit Satellites	12.24	Cycle Life	Wh/kg	Reliability	Safety	Ang	Ang	Ang	Ang	Low	Poor	Poor	Ang	Ang	Ang	++Ang	++Ang	++Ang
Geostationary Orbit Satellites	12.24	Cycle Life	Wh/kg	Reliability	Safety	Ang	Ang	Ang	Ang	Low	Poor	Poor	Ang	Ang	Ang	++Ang	++Ang	++Ang
Naval	88.64	Wh/kg	Cost	Self-Discharge	Cycle Life	Low	Ang	Ang	Good	Good	Low	Low	Ang	Ang	++Ang	++Ang	++Ang	++Ang
Motorcycle	84	Wh/kg	Cost	Cycle Life	Self-Discharge	Low	Ang	Ang	Low	Low	Low	Poor	Good	Low	++Ang	++Ang	++Ang	++Ang
Sports Car	89.15	Wh/kg	Power	Cycle Life	Self-Discharge	Ang	Good	Good	Ang	Ang	Poor	Poor	Good	Low	++Good	++Good	++Good	++Good
Automotive	235.9	Cost	Wh/kg	Cycle Life	Self-Discharge	Low	Ang	Ang	Ang	Ang	Poor	Ang	Ang	Ang	++Low	++Low	++Low	++Low
Sedan	393	Wh/kg	Cost	Cycle Life	Self-Discharge	Low	Ang	Ang	Ang	Good	Poor	Ang	Ang	Ang	++Low	++Low	++Low	++Low
Sports Utility Vehicle	270.88	Wh/kg	Cost	Cycle Life	Self-Discharge	Low	Ang	Ang	Ang	Good	Poor	Ang	Ang	Ang	++Low	++Low	++Low	++Low
Heavy Duty Vehicle	24.73	Wh/kg	Cost	Cycle Life	Self-Discharge	Poor	Ang	Low	Low	Low	Poor	Poor	Ang	Ang	++Ang	++Ang	++Ang	++Ang
Industrial Trucks	24.73	Wh/kg	Cost	Cycle Life	Self-Discharge	Poor	Ang	Low	Low	Low	Poor	Poor	Ang	Ang	++Ang	++Ang	++Ang	++Ang
Computers & Tablets	448.76	Wh/kg	Safety	Reliability	Cost	Good	Ang	Low	Ang	Low	Good	Low	Low	Poor	++Poor	++Poor	++Poor	++Poor
Smart Phones & Watches	588.12	Wh/kg	Safety	Reliability	Cost	Good	Ang	Low	Ang	Low	Good	Low	Low	Poor	++Poor	++Poor	++Poor	++Poor
Consumer Electronics	392	Power	Cost	Safety	Reliability	Good	Poor	Low	Ang	Low	Good	Low	Low	Poor	++Poor	++Poor	++Poor	++Poor
Power Tools & Sporting	48.7	Cost	Wh/kg	Safety	Reliability	Ang	Ang	Ang	Ang	Ang	Good	Low	Low	Poor	++Poor	++Poor	++Poor	++Poor
E-Bikes	48.7	Cost	Wh/kg	Safety	Reliability	Ang	Ang	Ang	Ang	Ang	Good	Low	Low	Poor	++Poor	++Poor	++Poor	++Poor
Grid Storage (Residential)	120	Cost	Cycle Life	Reliability	Safety	Good	Low	Low	Good	Good	Poor	Poor	Poor	Good	++Good	++Good	++Good	++Good
Grid Storage (Commercial)	97.8	Reliability	Safety	Cost	Cycle Life	Ang	Low	Low	Good	Good	Ang	Ang	Ang	Poor	++Poor	++Poor	++Poor	++Poor
Grid Storage - Smart Grid	97.8	Reliability	Safety	Cost	Cycle Life	Ang	Low	Low	Good	Good	Ang	Ang	Ang	Poor	++Poor	++Poor	++Poor	++Poor
Defibrillators	13.34	Safety	Reliability	Power	Self-Discharge	Ang	Low	Low	Ang	Low	Low	Poor	Low	++Ang	++Ang	++Ang	++Ang	++Ang
Medical Devices	14.28	Safety	Reliability	Power	Cycle Life	Ang	Low	Low	Ang	Low	Low	Low	Good	Poor	++Low	++Low	++Low	++Low
Surgical Tools	14.28	Safety	Reliability	Power	Cycle Life	Ang	Low	Low	Ang	Low	Low	Low	Good	Poor	++Low	++Low	++Low	++Low
Prosthetics	4.4	Safety	Reliability	Power	Cycle Life	Ang	Low	Low	Ang	Low	Low	Low	Good	Poor	++Low	++Low	++Low	++Low
Wearable Devices	22.548	Cycle Life	Cost	Safety	Reliability	Low	Low	Low	Ang	Low	Low	Ang	Good	Poor	++Poor	++Poor	++Poor	++Poor
Industry	309.77	Reliability	Safety	Wh/kg	Self-Discharge	Poor	Ang	Ang	Poor	Low	Poor	Poor	Good	Poor	++Good	++Good	++Good	++Good
Backup Power	309.77	Reliability	Safety	Wh/kg	Self-Discharge	Poor	Ang	Ang	Poor	Low	Poor	Poor	Good	Poor	++Good	++Good	++Good	++Good
Military	309.77	Power	Wh/kg	Wh/kg	Reliability	Good	Ang	Ang	Ang	Ang	Good	Low	Low	Poor	++Good	++Good	++Good	++Good
Drones	309.77	Power	Wh/kg	Wh/kg	Reliability	Good	Ang	Ang	Ang	Ang	Good	Low	Low	Poor	++Good	++Good	++Good	++Good

\* Cell design and components other than the cathode can make a very large difference in cell performance metrics. Ratings marked with \*\* are based on published data but have no commercial cells.

### KEY DEVELOPMENTS:

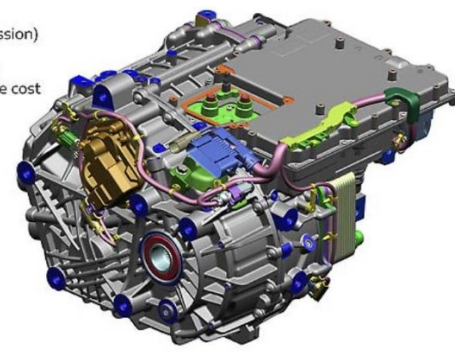
- GM, Ford, and CATL scaling LFP
- Natron Energy leading U.S. sodium-ion development
- Lyten shipped first pilot line Li-S batteries
- **New chemistries and cell formats targeting specific markets – cells designed to application and market**
- **Addressable market grows with increasing energy density and reduced costs**
- **Solid State growth driven by need for increasing energy density**
  - **Initial higher manufacturing cost offset by improved performance**



Source: Research and Markets | Nov 13, 2024

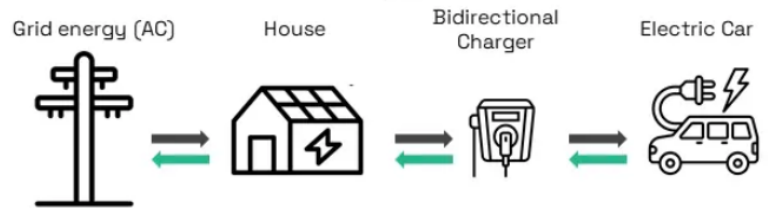
## 7 – EREV's, Fast / bidirectional charging

- All-in-one solution for EV powertrains (electric motor, power electronics, transmission)
- Delivers improved performance and range (up to 500 miles / 800 km) at a competitive cost
- Integrated into STLA Frame and STLA Large vehicles



STELLANTIS

### Bidirectional V2G/V2H



### KEY DEVELOPMENTS:

- NACS and MCS Charging enabling consistent, convenient EV charging
- Zeeker claims its upgraded batteries can be charged from 10% to 80% capacity in 10 and a half minutes using its ultra-fast charging stations
- Ram 1500 EREV launch combining serial hybrid configuration for 350 mile range; ICE only acts as generator
- Bidirectional charging allowing consumer to participate in "Virtual Power Plant" network, purchasing electricity at low rates and allowing powerflow back to grid at peak rates
- **"Range extender" EV's open up market in LDT's and longer range EV's for rural applications**
- **Combination of high energy density, high cycle life batteries enabling new model for consumer asset utilization, offsetting vehicle depreciation with revenue generation**



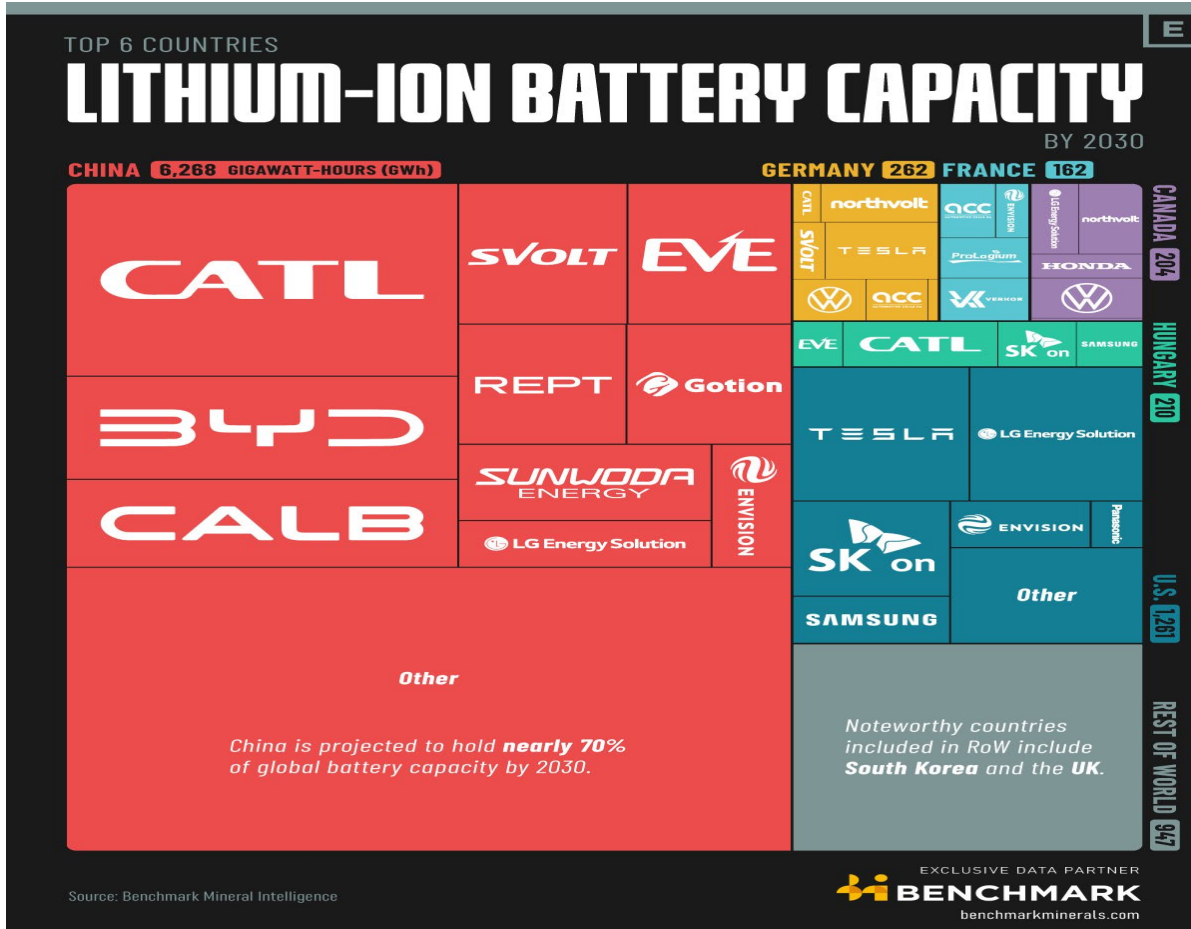
## 8 - Fire Safety Innovations

### KEY DEVELOPMENTS:

- New containment technologies, regulatory push for safer packaging. (CSA, NFPA, SAE, UL)
- Increased focus on public education campaigns regarding safe storage and charging practices,
- Stricter regulations on low-quality batteries in development
- Early detection systems for overheating batteries
- Collaborative efforts between fire departments, regulatory agencies, and industry



## 9 - Global Competition Rises



### KEY DEVELOPMENTS:

- Chinese battery manufacturers looking abroad for partnerships
- Indonesia now controls 61% of refined nickel production
- **Regional policies now driving investment into regional supply chains and localization**
  - **Regional market protection has limited and short-term affect on local supply chains if they aren't efficient and capable of competing in global market**
- **Battery manufacturers with early scale are reinvesting heavily in innovation and increased energy density, reduced costs**
- **"Moore's Law" equivalent for battery R&D?**



## 10 – “Co-opertition”: Strategic Mergers & Partnerships

### KEY DEVELOPMENTS:

- Ford-BlueOval SK expansion.
- GM joint venture with Lithium Americas to develop the Thacker Pass lithium mine in Nevada
- Stellantis and CATL Joint Venture
- Rio Tinto is acquiring Arcadium Lithium
- Volvo Cars' Buyout of Northvolt's Gigafactory Stake announced
- Stellantis & CATL's \$4.1 Billion LFP Battery Plant Investment
- ***“Co-opertition” will create new business models and relationships***
- ***Industry needs access to best available technology, resources, and experience needed regardless of geopolitics***



# Thank You!

