The future of EV battery manufacturing

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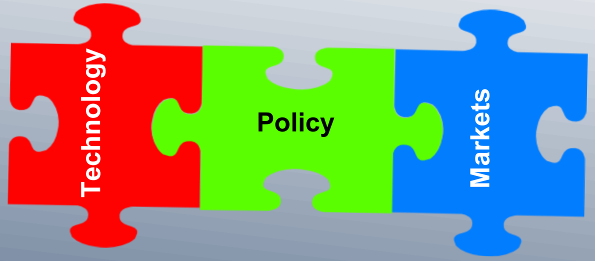
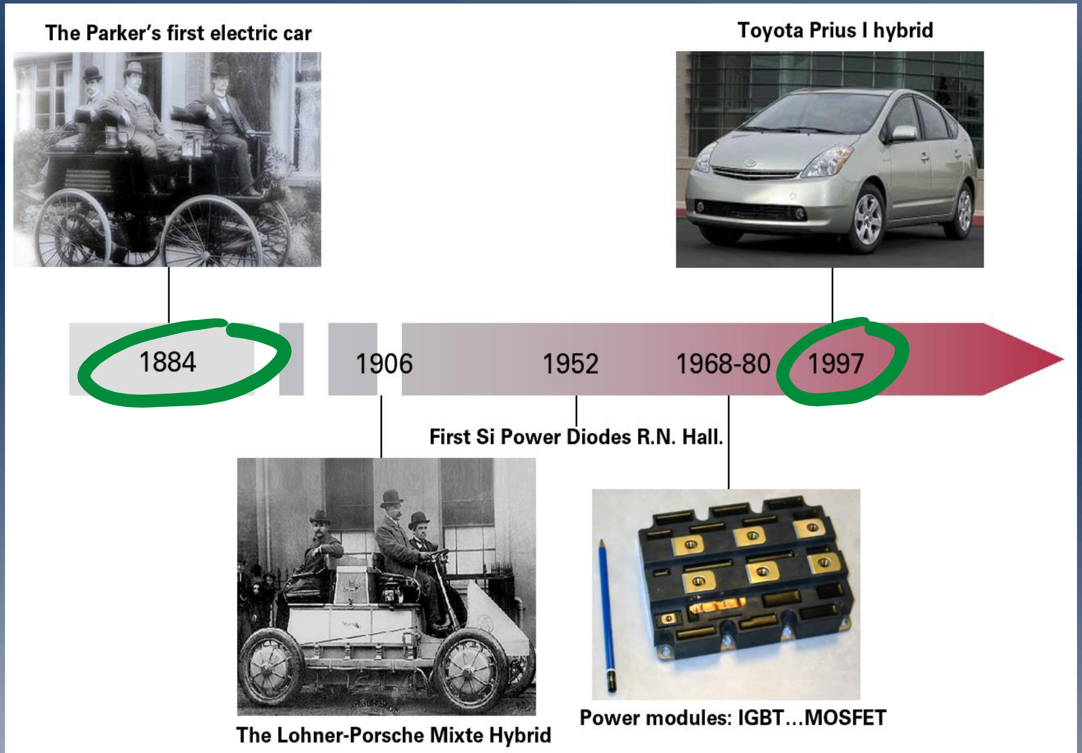
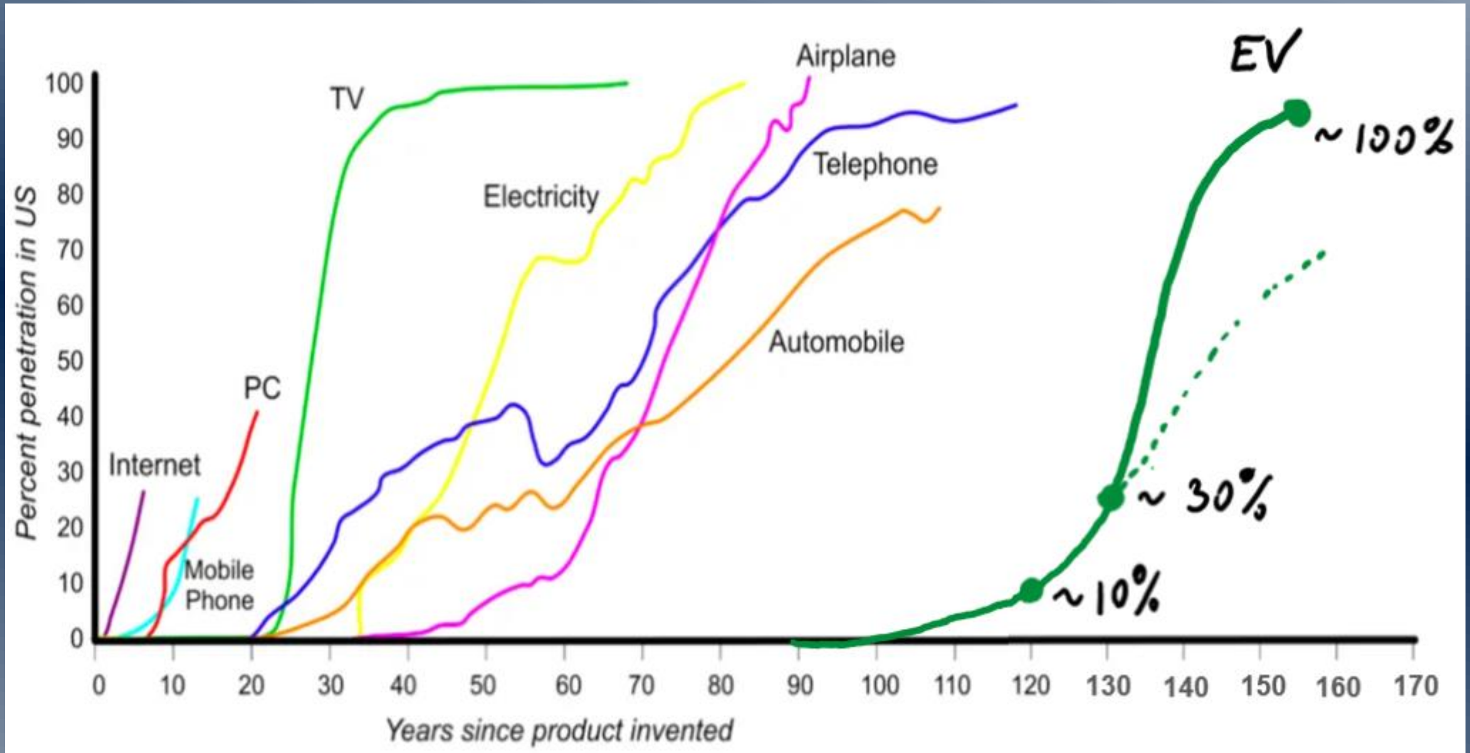
S-Curve

Main Drivers: Technology, Policy, Markets

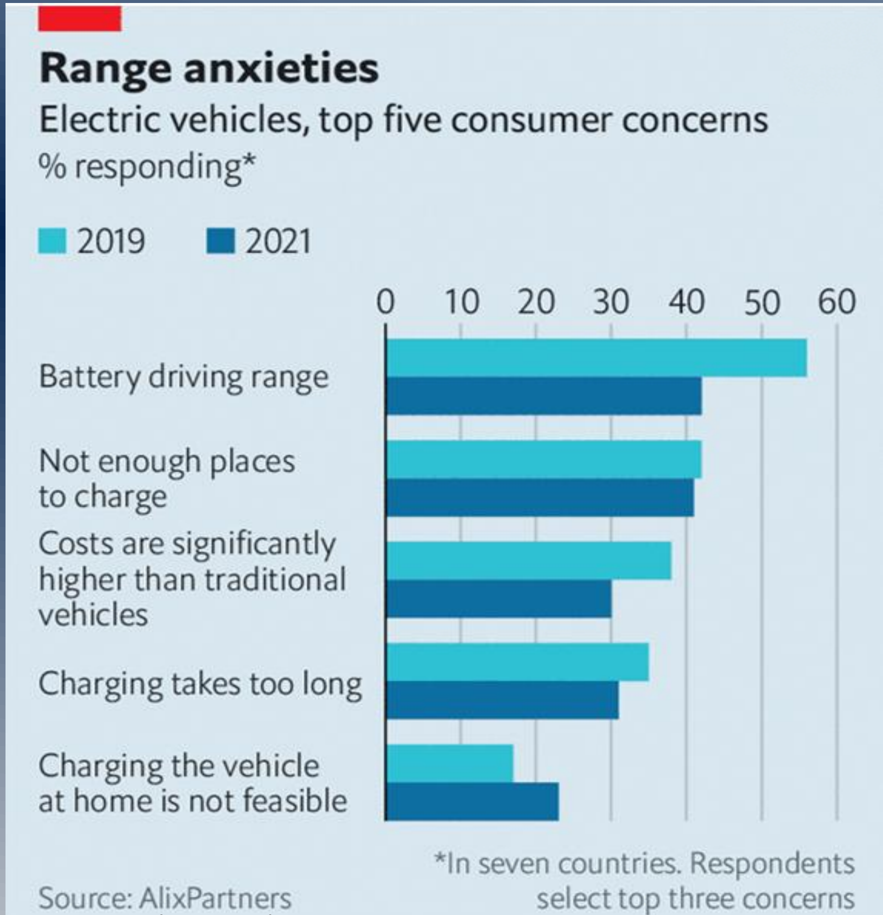






Source: https://www.caroli.org/en/the-technology-adoption-curve/

Trends Electric Passenger Vehicles



The Economist

Range

> 500 km

Super Fast Charging

800 V // > 350 kW

Cost

material costs // volume //

production costs

Lifespan and Safety

residual value,

optimized cooling configurations

Building Blocks

degrease in production costs //
new production processes

Energy Density

cell to pack // cell to chassis //
new formfactors // new cell chemistries

Second Life

refurbishment // alternative applications

Diagnostics

data management // digital production twin // digital product twin

Horizontal Integration

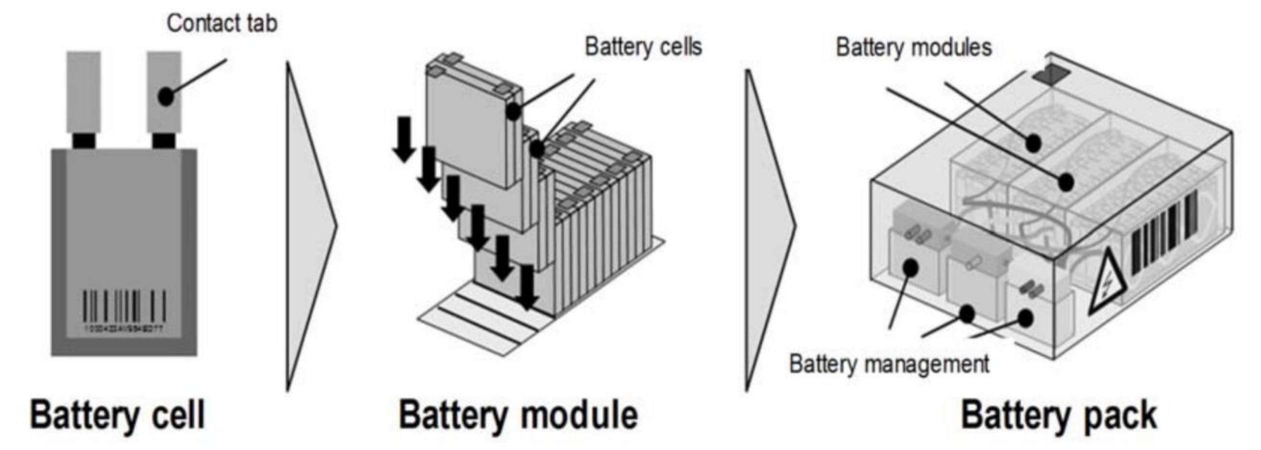
Tier 1 as an interface between Cell Supplier and OEM

Raw Material → Cell → Module components → Module assembly → Pack components → Pack assembly → Second Life → Battery recycling

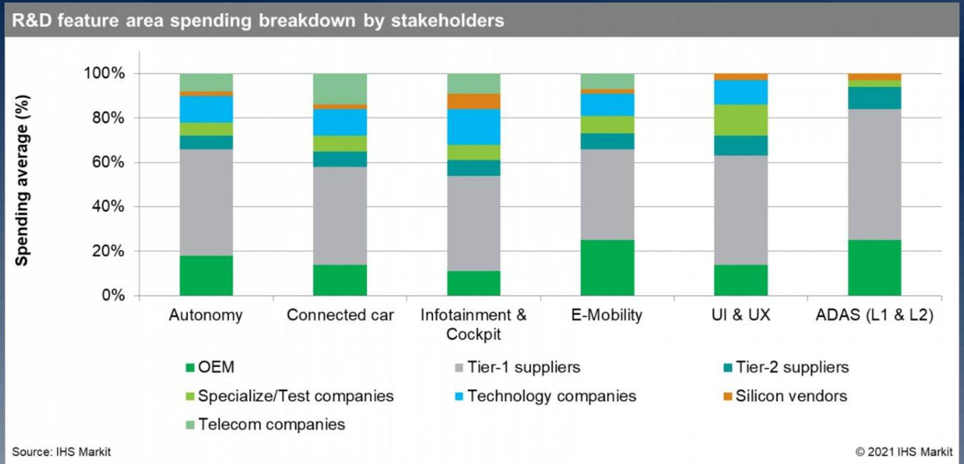
OEM (Horizontal BM)

Tier1 Supplier (Production cost per system 10-15%)

Cell Supplier



Source: Evaluation of a Remanufacturing for Lithium Ion Batteries from Electric Cars, Achim Kampker, Heiner H. Heimes, et al..



Vertical Integration

Reduced role of Tier 1

Raw Material → Cell → Module compoenents → Module assembly → Pack components → Pack assembly → Second Life → Battery recycling

OEM (Vertical BM)

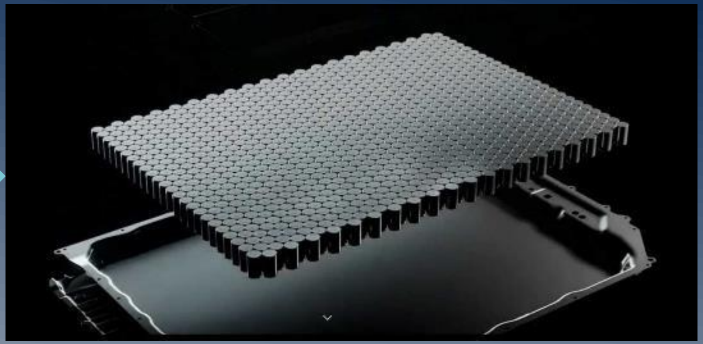
Tier1 Supplier (Production cost per system 2 - 5 %)

Cell Supplier

Cell-to-module

Cell-to-pack

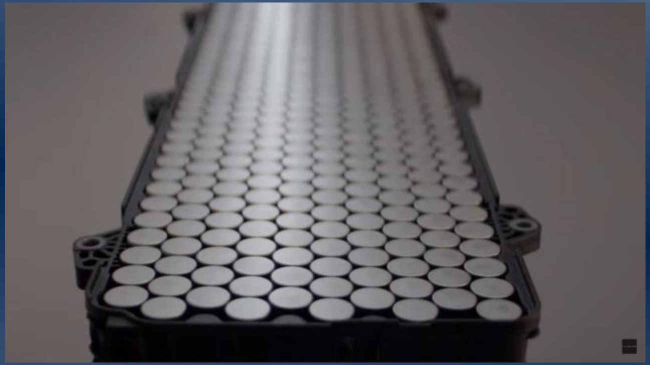
Cell-to-chassis

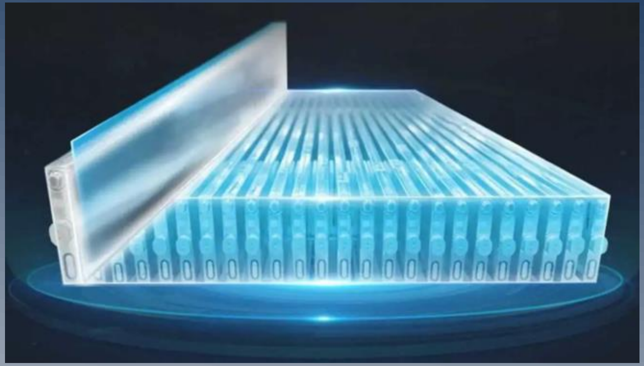


Sources: P3 Group, insideEVs, CleanTechnica, Tesla

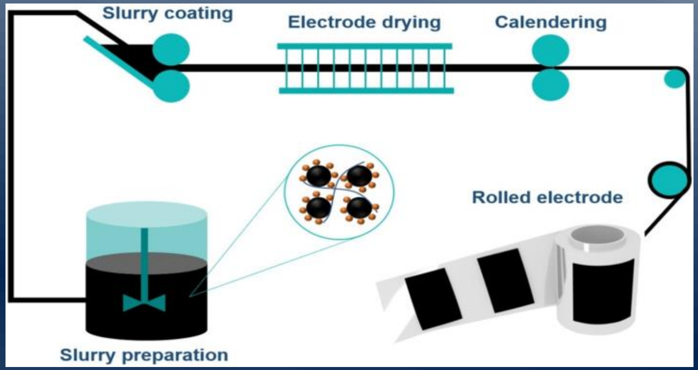
Future Trends for High Performance EV Batteries

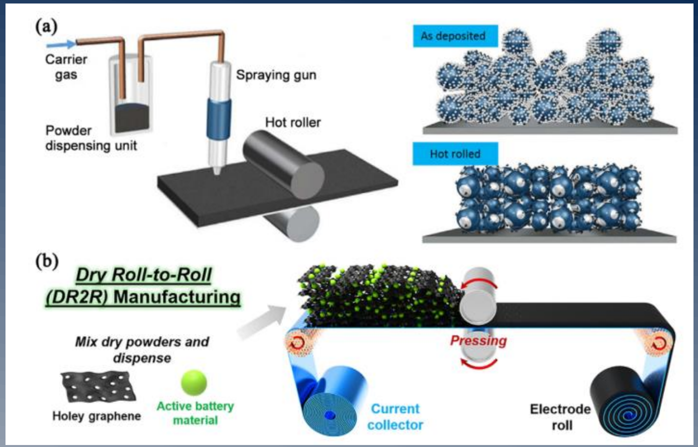
System/Cell Design



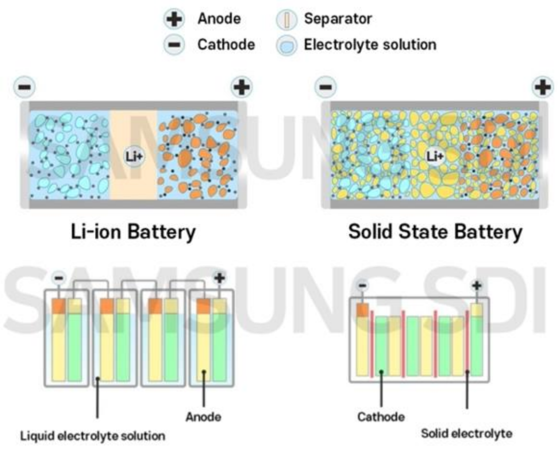


Process





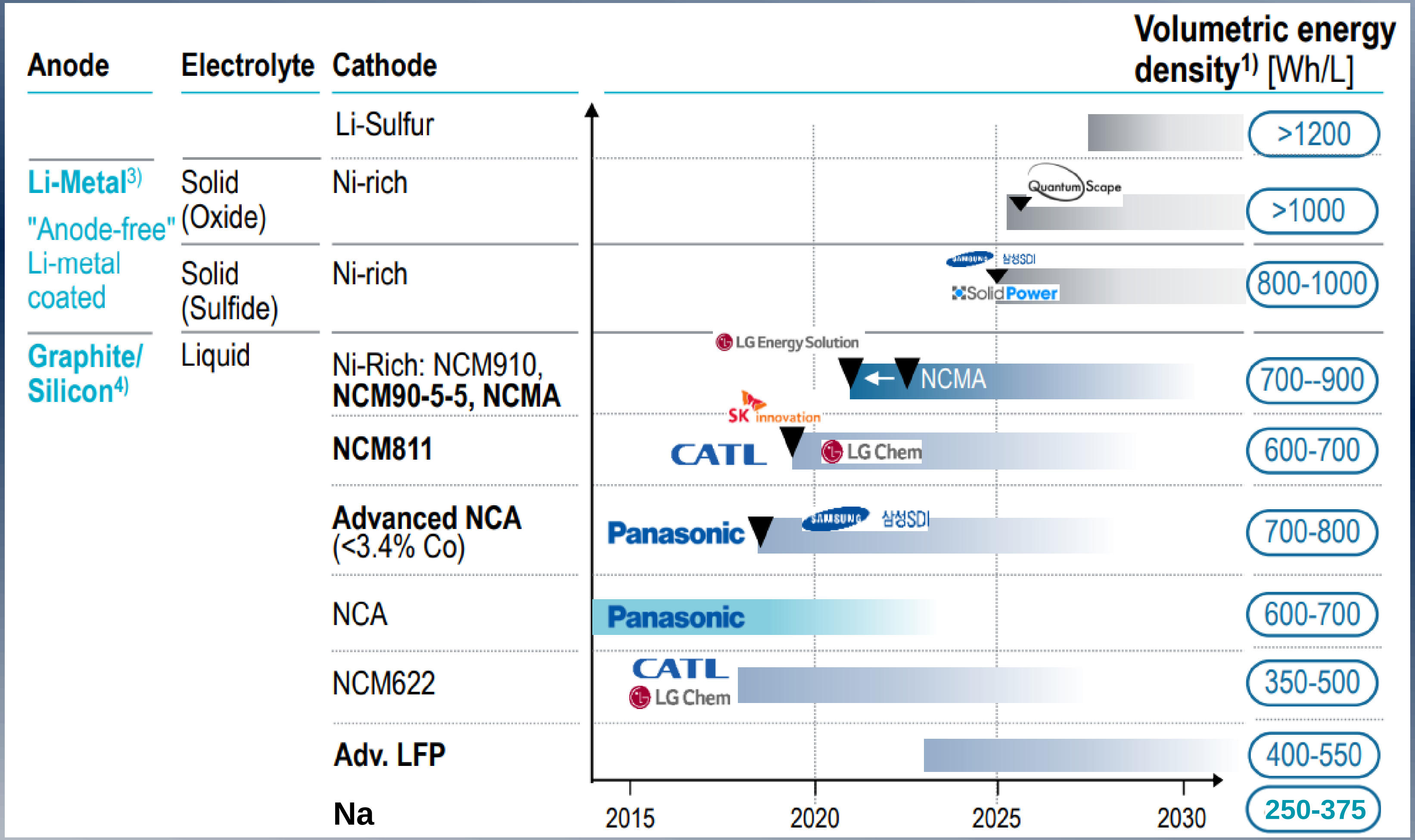
Chemistry



Sources: Lucid, BYD, CATL, Samsung SDI, Advanced electrode processing of lithium ion batteries: A review of powder technology in battery fabrication H. Liua,b, X. Chengc, Y. Chongc...

Future Trends for High Performance EV Batteries

Technology progress in chemistries



Next-Gen Technology (> 2025)

- Solid state: Introduction of oxide and sulfite-based, anode-free and with Li-metal-coated anodes
- Hi-Si anodes even before
- LFP for lower range/A-/B-segment-, selected CV use cases, and as option
- Ni-rich tech. for high energy use cases
- NMx "in-between" NCM and LFP from cost and energy density perspective
- Mn-rich technologies as cheaper alternative for volume vehicles
- Cell-to-Pack-technologies to in-crease energy density on system level

Source: Roland Berger

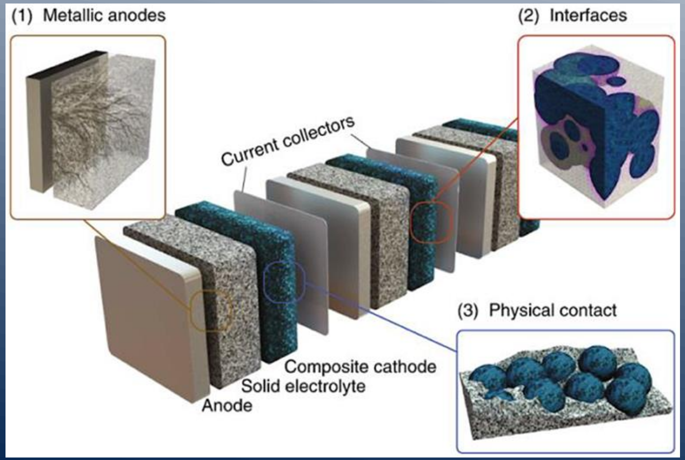
Battery Chemistries Development - Solid-State

Process Flow for Liquid Electrolytes LiB

Pouch Cell										
Mixing	Coating	Calendaring	Slitting	Shaping	Electrode Stacking	Separator Stacking	One Side Sealing	ELT Filling	Formation Inspection	Degassing

Modul			
Cell Assembly	Tab Welding	Inserting and Sealing	Module Inspecting

Pack			
Module Connecting	BMS Assembling	High Voltage Control Unit Assembling	Pack Assebling



Process Simplification > 40%

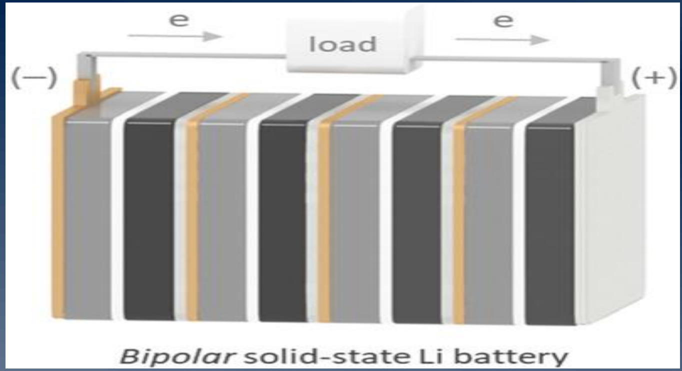
Cycle Time > 200%

Process Flow for Solid-State Electrolytes LiB

Pouch Cell						
Mixing	Coating	Calendaring	Sealing Glue	Electrode Assembling	Lamination	Formation Inspection

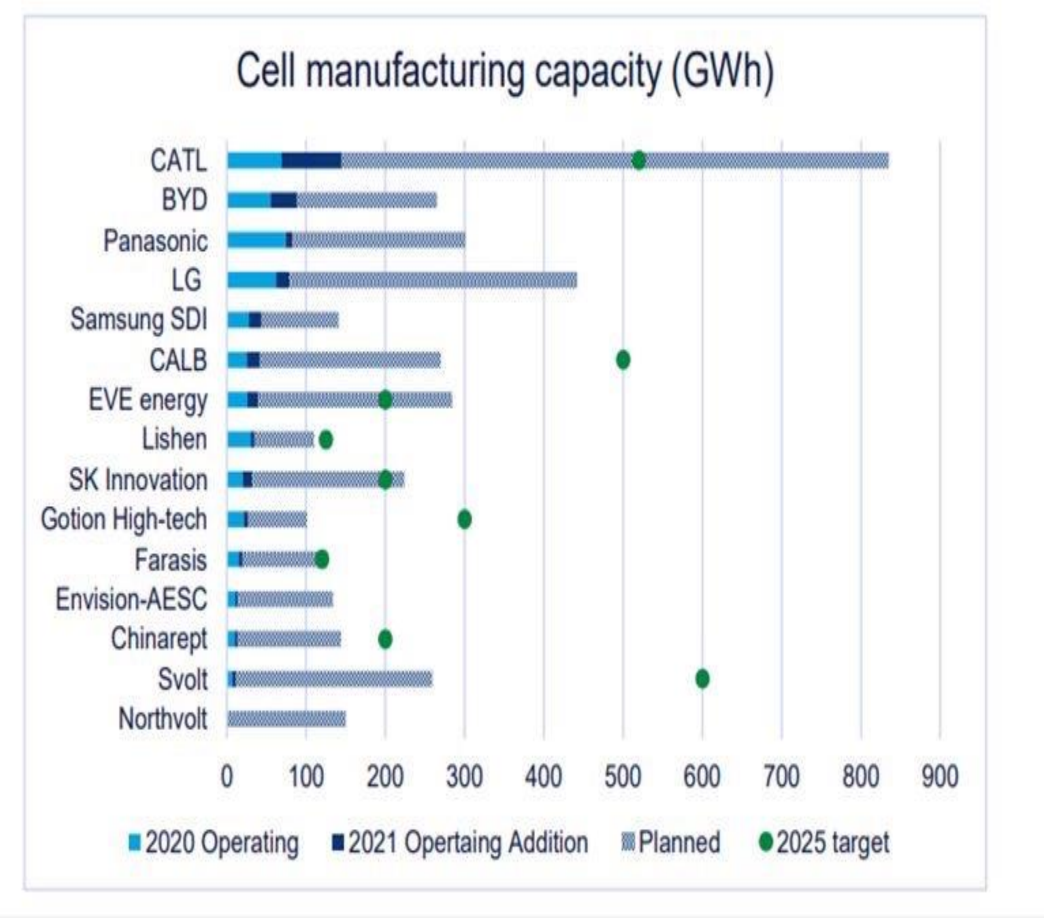
Modul

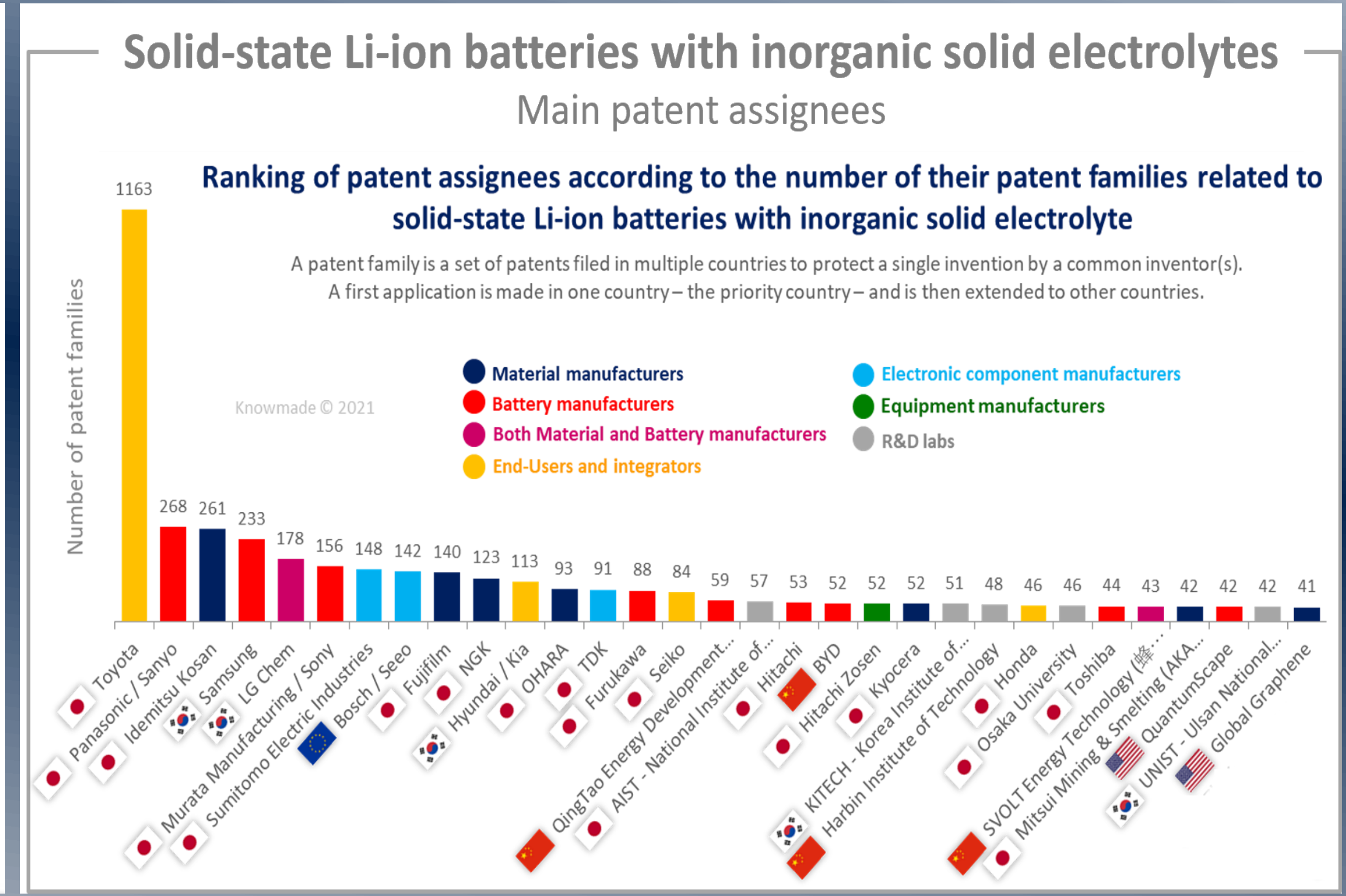
Pack			
Inset Stacking	BMS Assembling	High Voltage Control Unit Assembling	Pack Assebling



Sources: Fundamentals of Electrolytes for Solid-State Batteries: Challenges and Perspectives, Liguang W. Jun Li, …. Solid-State Lithium Batteries: Bipolar Design, Fabrication, and Electrochemistry, Kyu-Nam J., Hyun-Seop S.…

Solid-State Li-ion Batteries Patent Landscape 2021





Sources: Know Made

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Battery Management Systems

Listed group

27,097 members

999+

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