

Automotive
LOGISTICS
& SUPPLY CHAIN

EUROPE

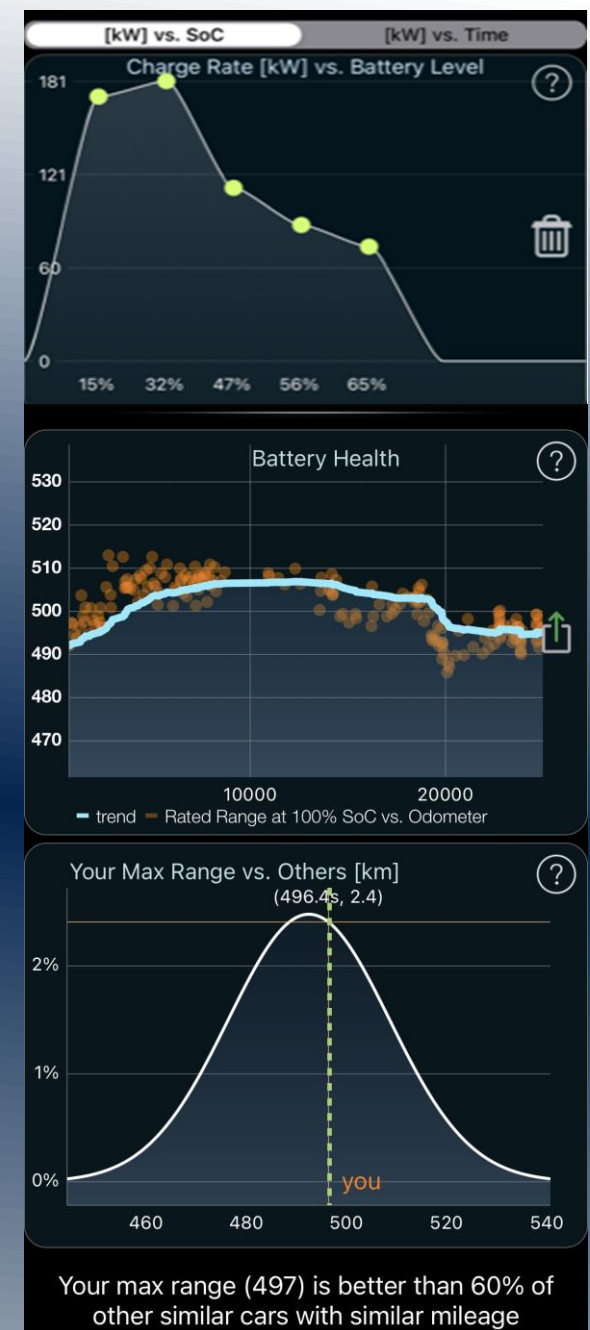
2-4 May 2022 | INFINITY Munich

Future E-mobility: A journey into the unknown for the supply chain

Dr Grzegorz (Greg) Ombach, Head of Disruptive R&T

03.05.2022

E-Mobility – My Experience



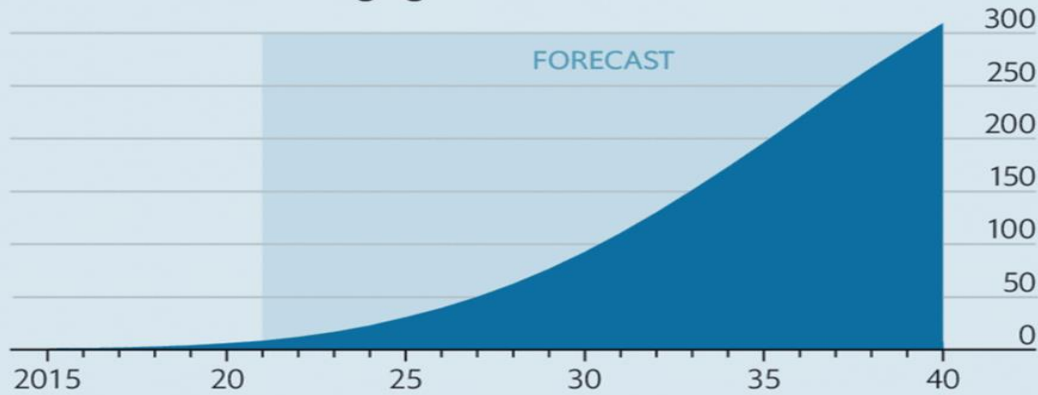
E-Mobility – My Experience



Charge of the lightweight brigade

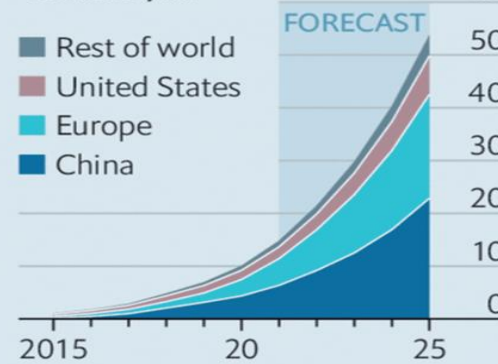
Electric vehicles

Global number of charging connectors, m



Source: BloombergNEF The Economist

Number of passenger vehicles, m

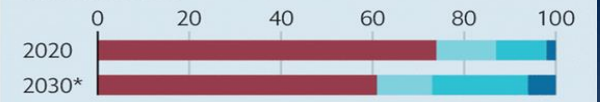


Highly charged

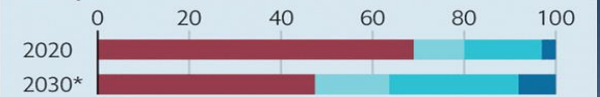
Electric-vehicle charging demand, by location, %

Private
Public City Highway Countryside

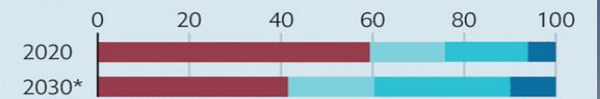
United States



Europe

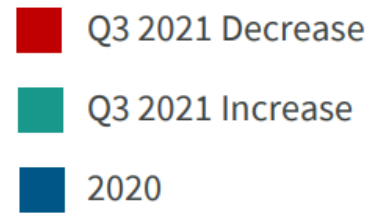
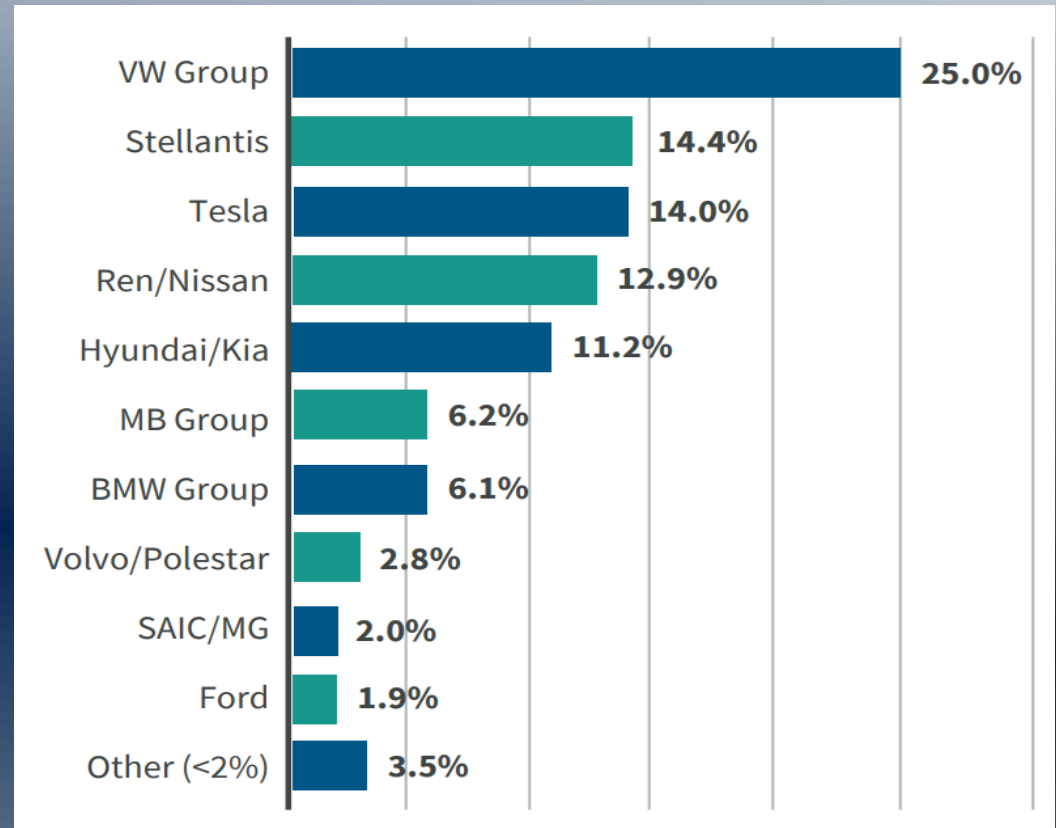
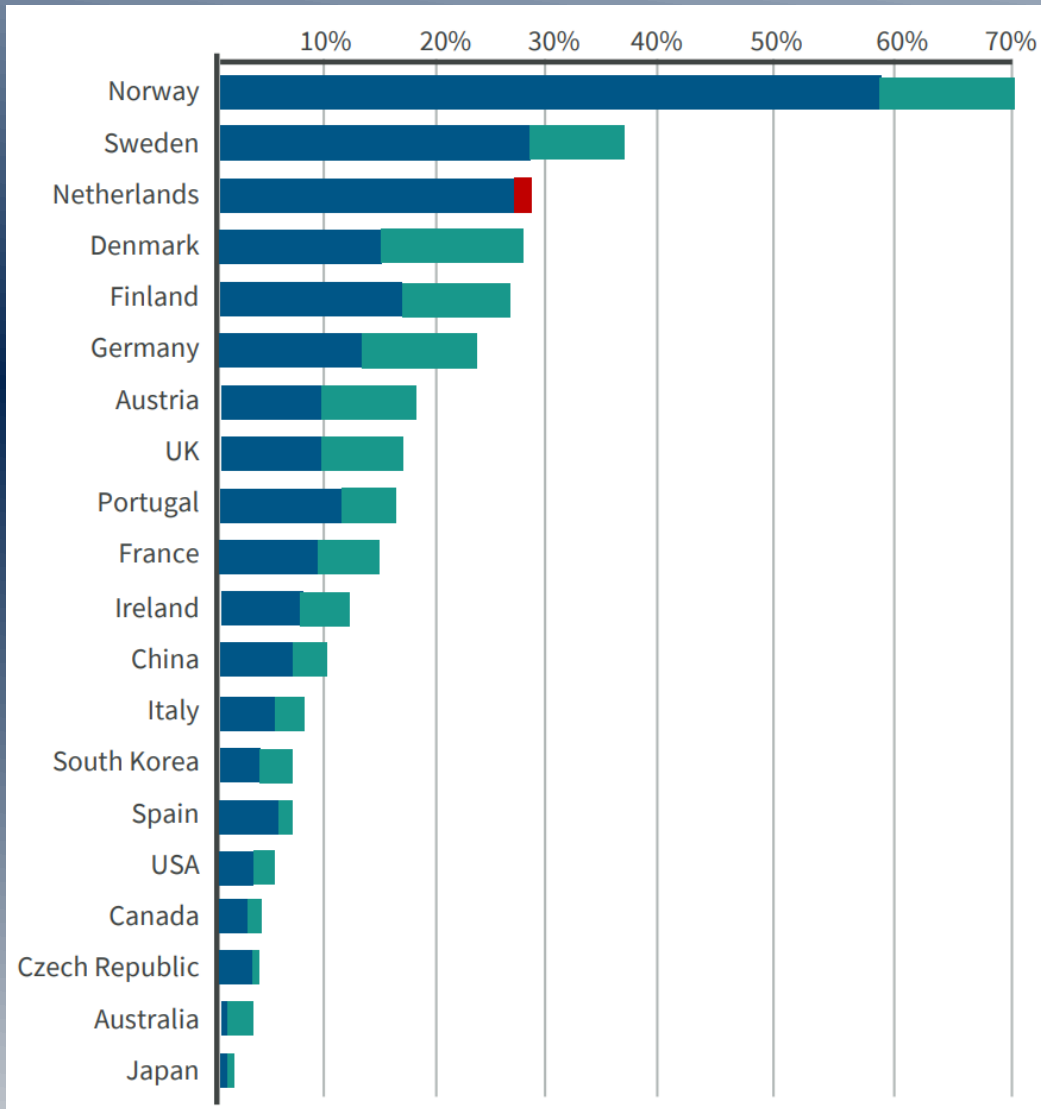


China



Source: Boston Consulting Group The Economist *Forecast

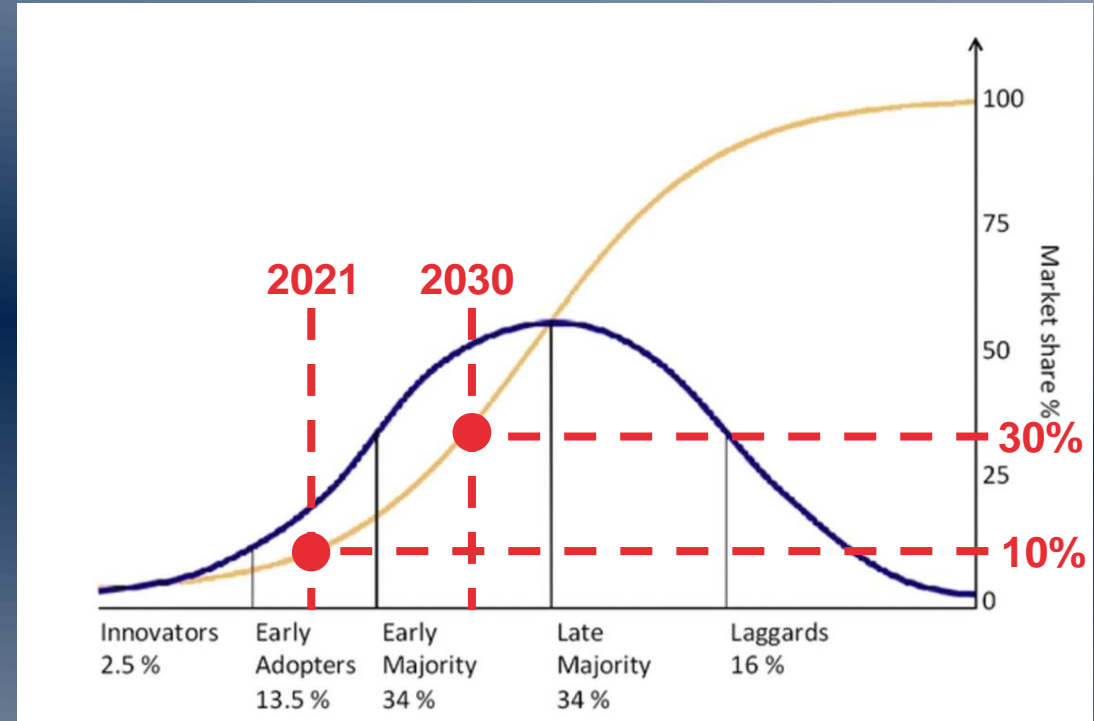
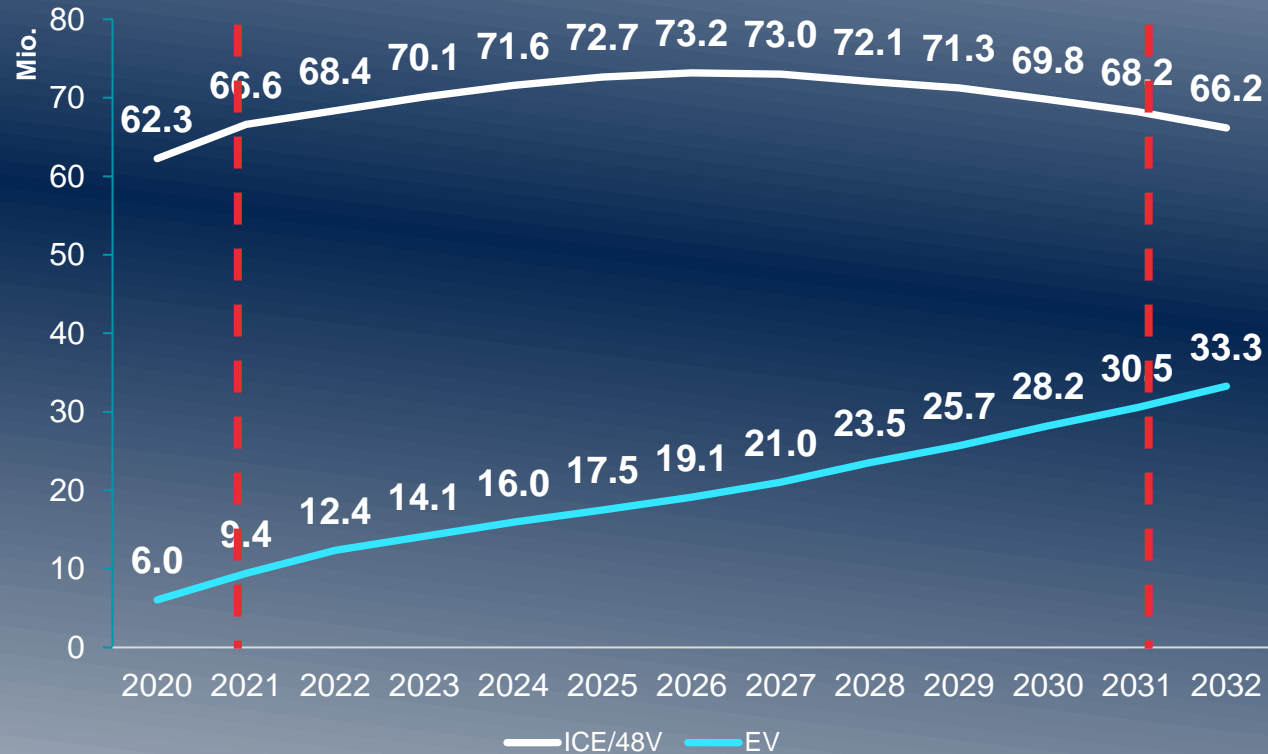
E-Mobility – EV Penetration Rates 2020 vs 2021



Source: Vendigital

Sales Forecast ICE vs. EV worldwide 2020-2032

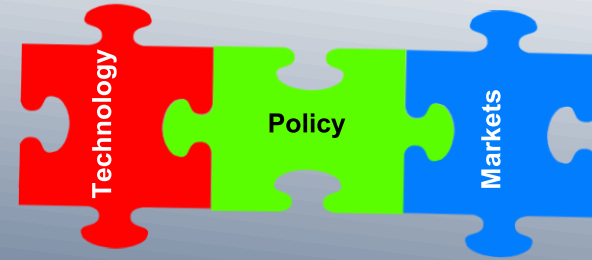
Passenger vehicles



Source: LMCA Global Light Vehicle Sales Forecast Q4/2020

S-Curve

Main Drivers: Technology, Policy, Markets



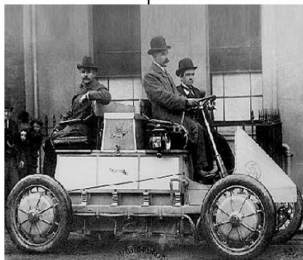
The Parker's first electric car



Toyota Prius I hybrid



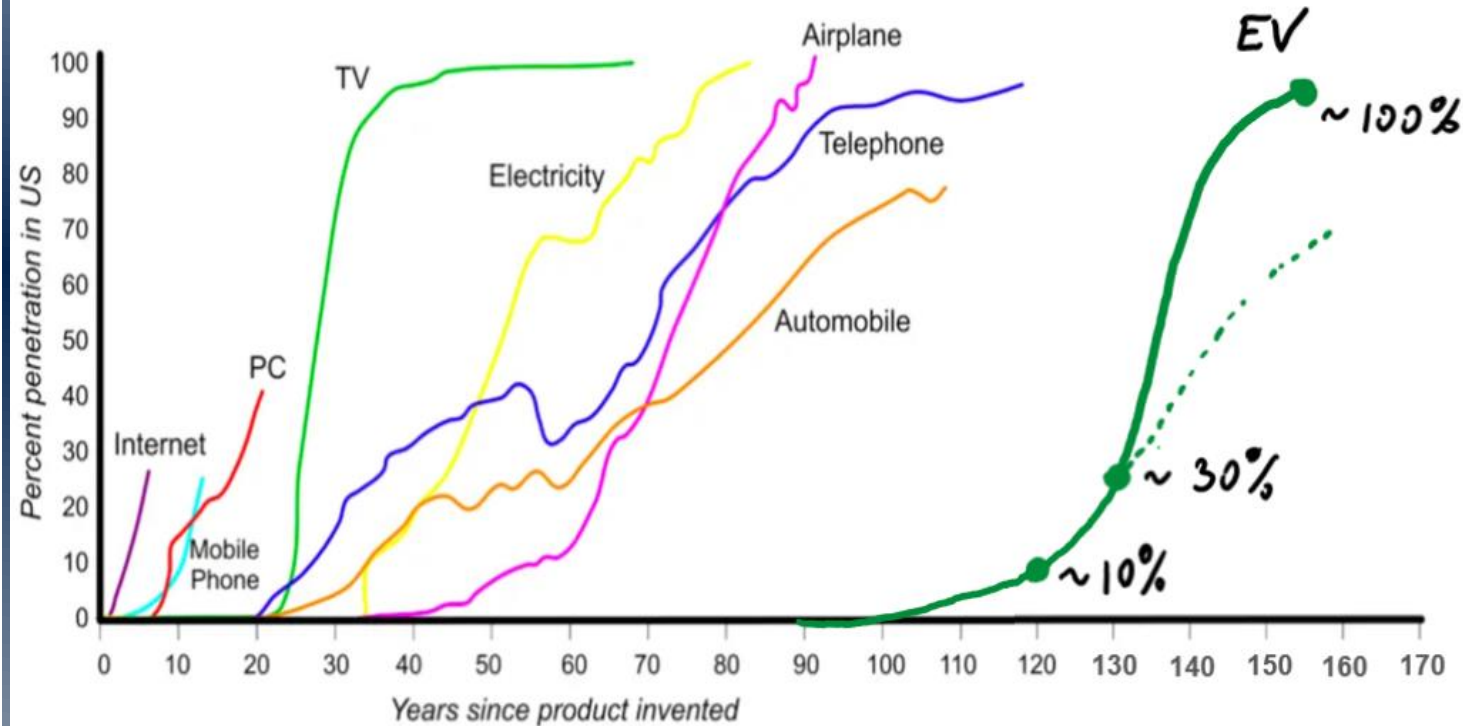
First Si Power Diodes R.N. Hall.



The Lohner-Porsche Mixte Hybrid



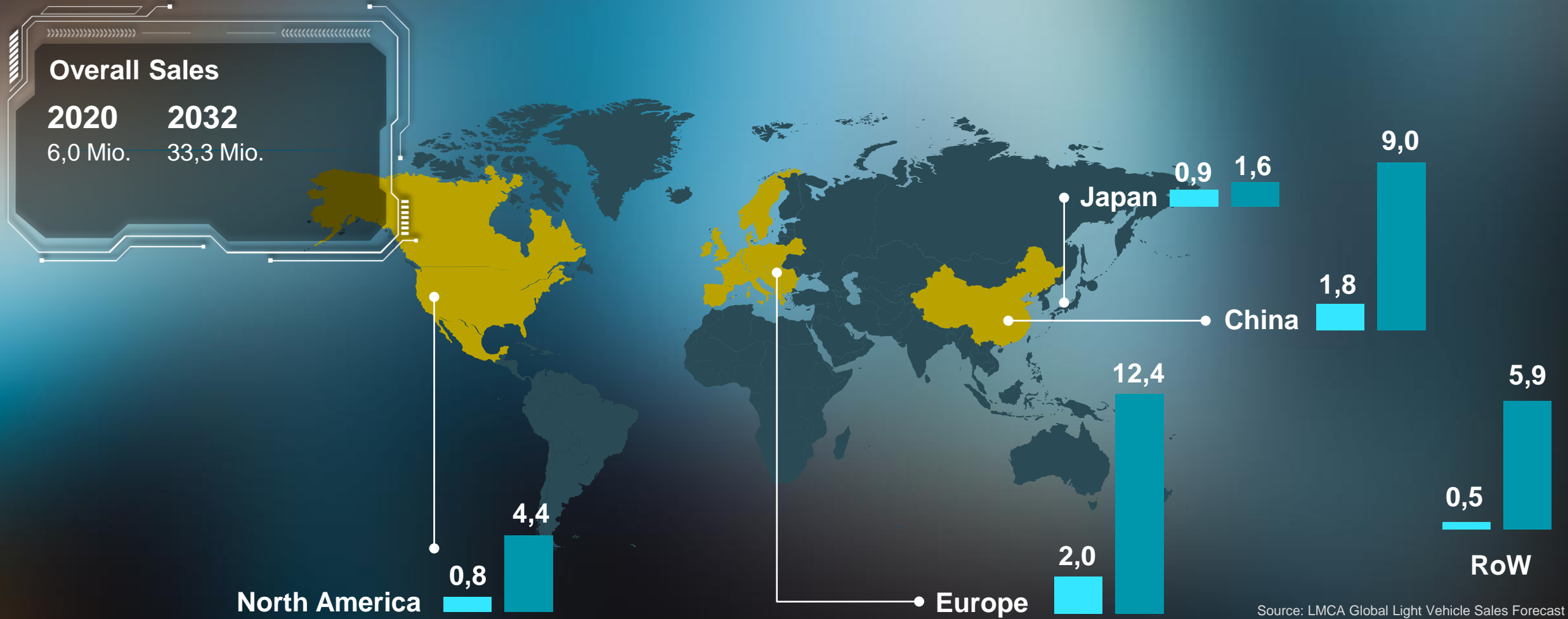
Power modules: IGBT...MOSFET



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

Regional Sales Forecast EV worldwide 2020-2032

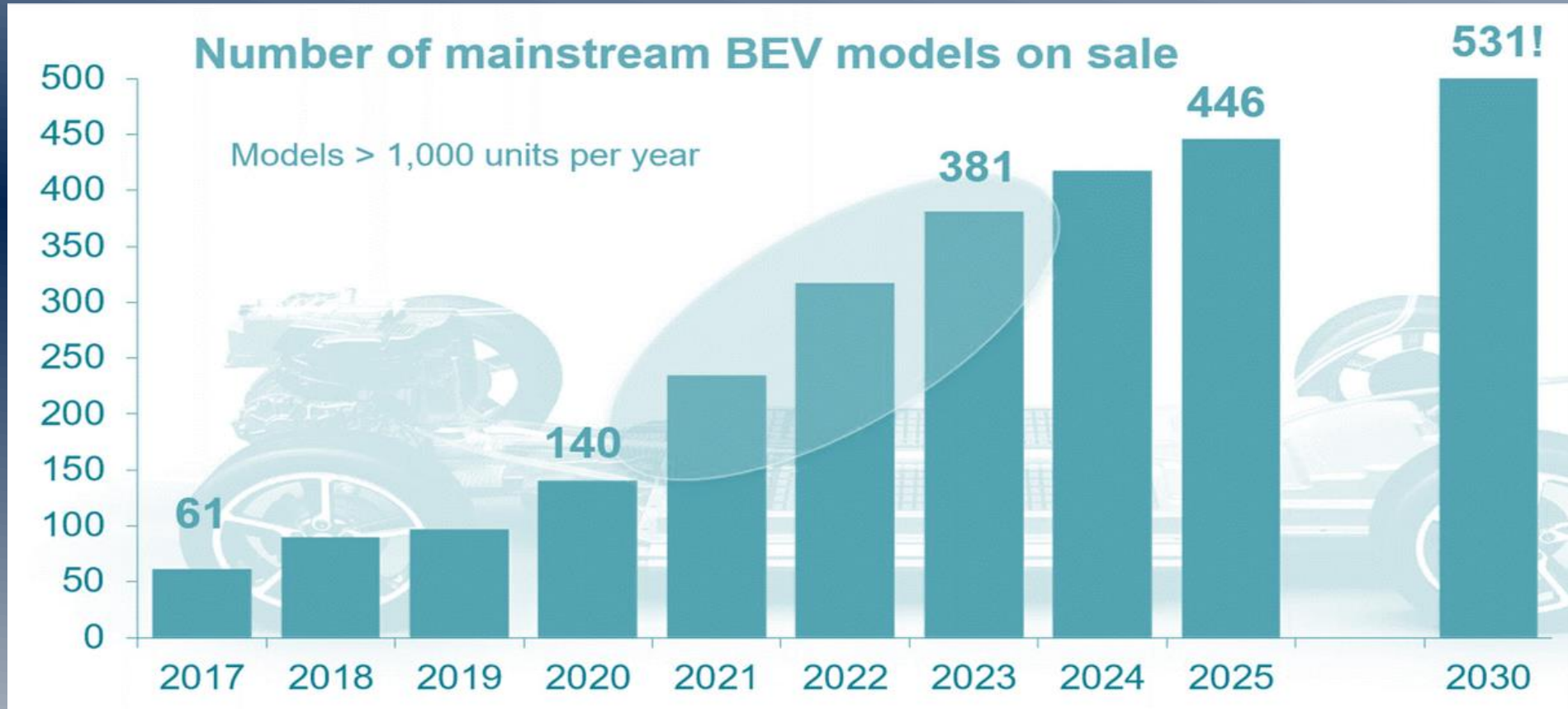
Passenger vehicles



Source: LMCA Global Light Vehicle Sales Forecast Q4/2020

Number of BEV-models available worldwide 2017-2030

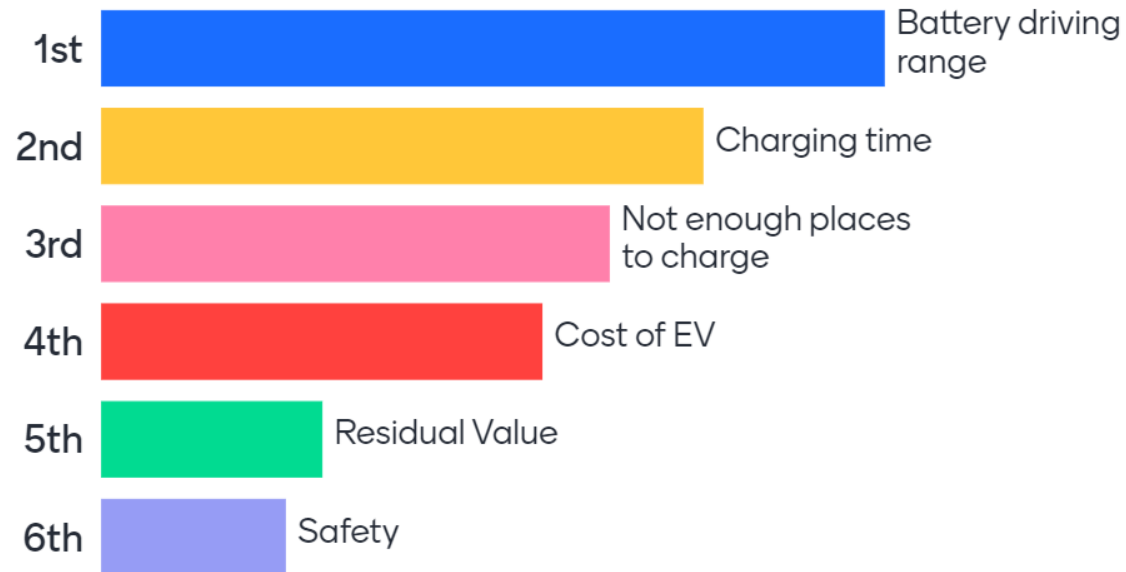
Passenger vehicles



Source: LMCA Global Light Vehicle Sales Forecast
Q4/2020

Poll No 1 – What are the top EV Consumer Concerns? Please rank them.

Top EV Consumer Concerns



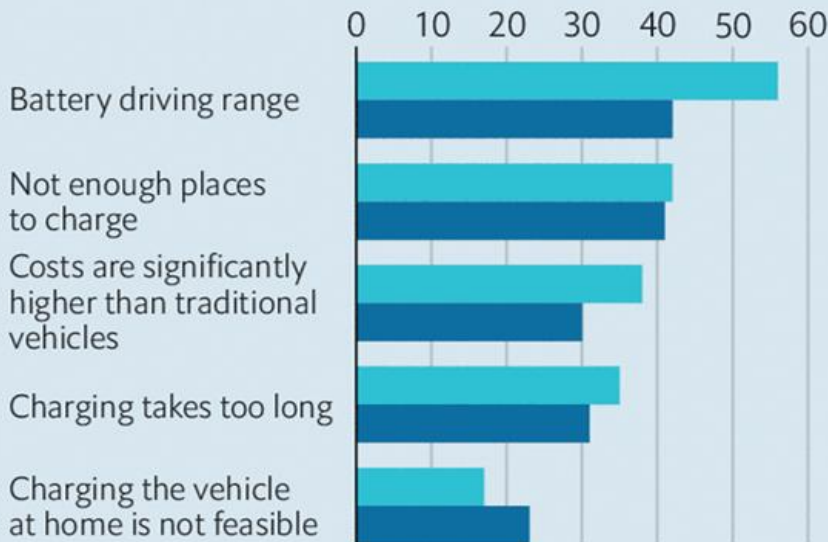
Trends Electric Passenger Vehicles

Range anxieties

Electric vehicles, top five consumer concerns

% responding*

2019 2021



*In seven countries. Respondents select top three concerns

Source: AlixPartners
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

decrease 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

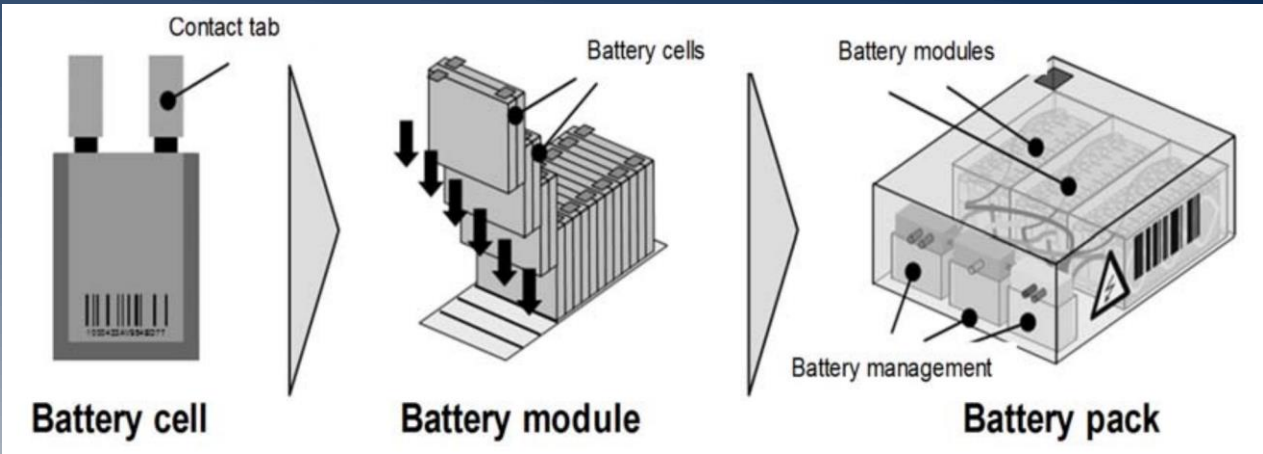
Horizontal Integration

Tier 1 as an interface between Cell Supplier and OEM

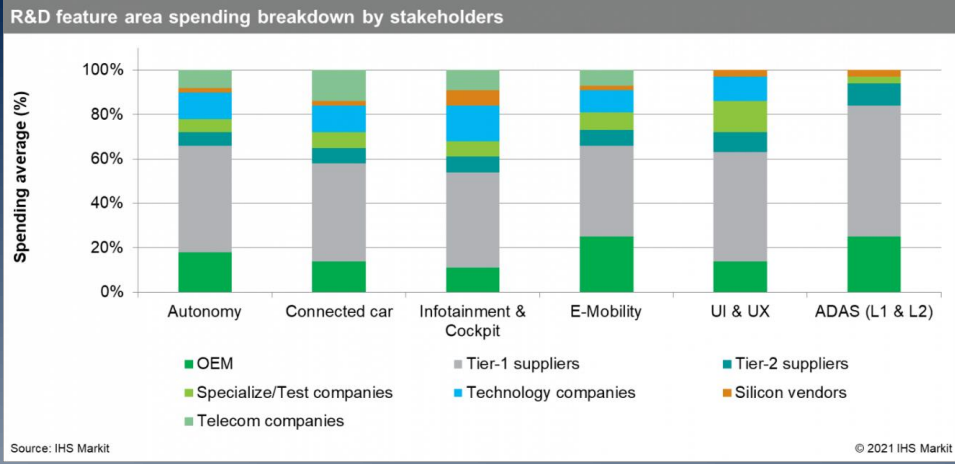


Tier1 Supplier (Production cost per system 10-15%)

Cell Supplier



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

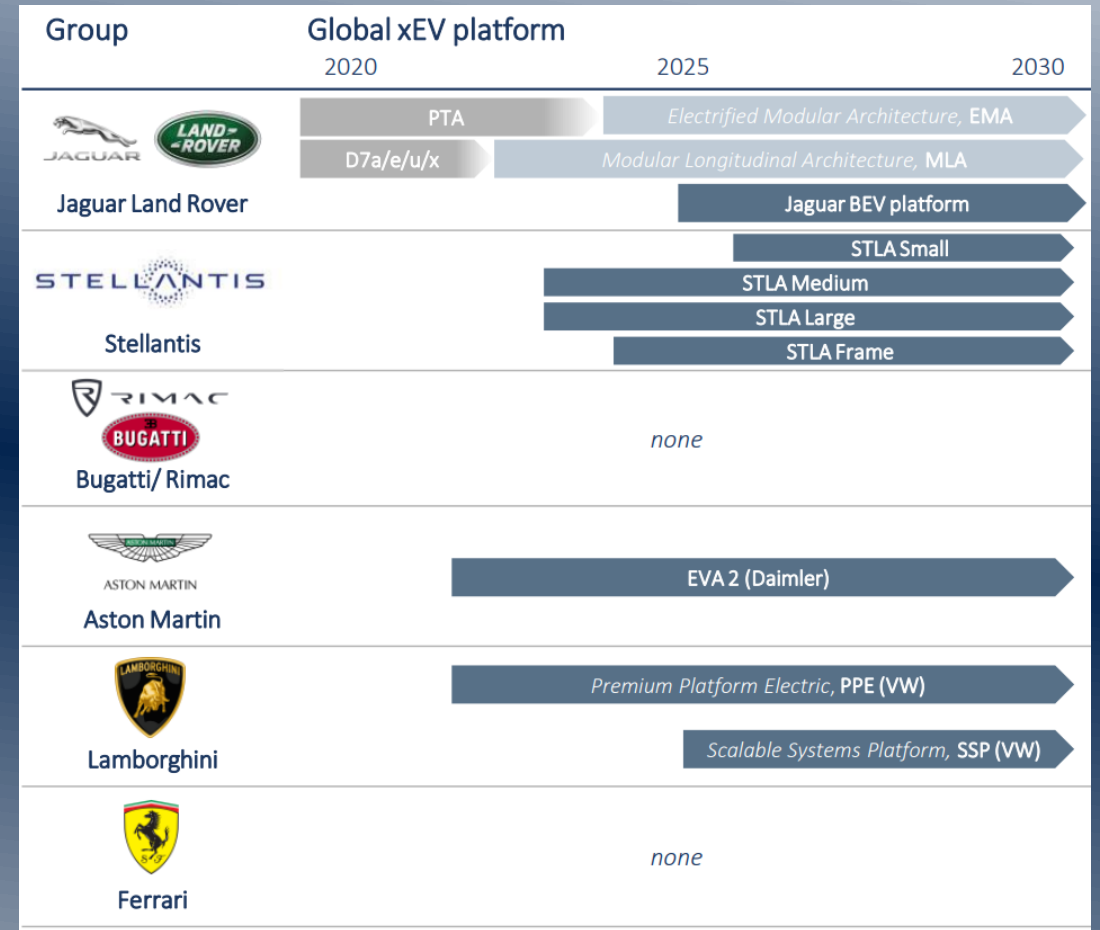
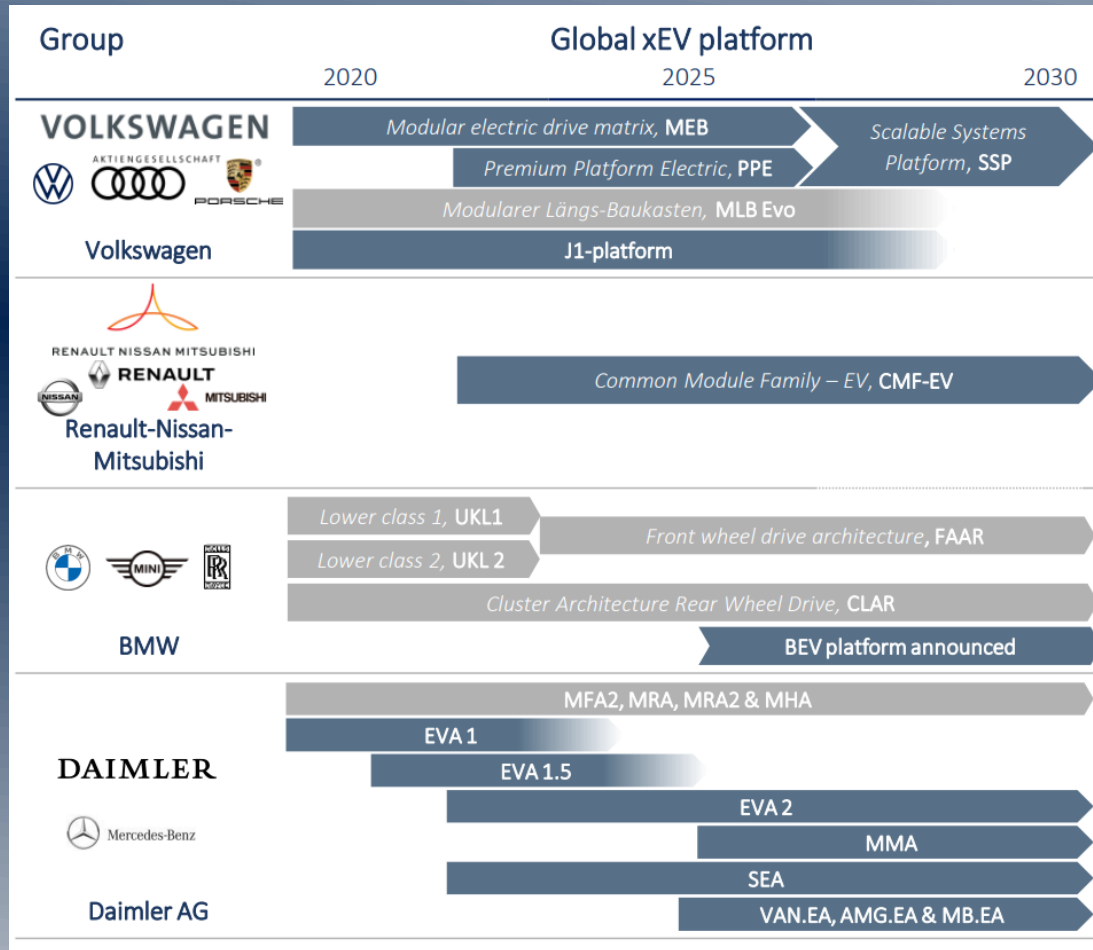


Source: IHS Markit

© 2021 IHS Markit

Vertical Integration

OEM Platform strategies Europe



Multi-energy platform
 xEV platform
 BEV platform

Source: P3

Vertical Integration

Reduced role of Tier 1



Sources: P3 Group, insideEVs, CleanTechnica, Tesla

800V-Technology

Porsche Taycan battery system

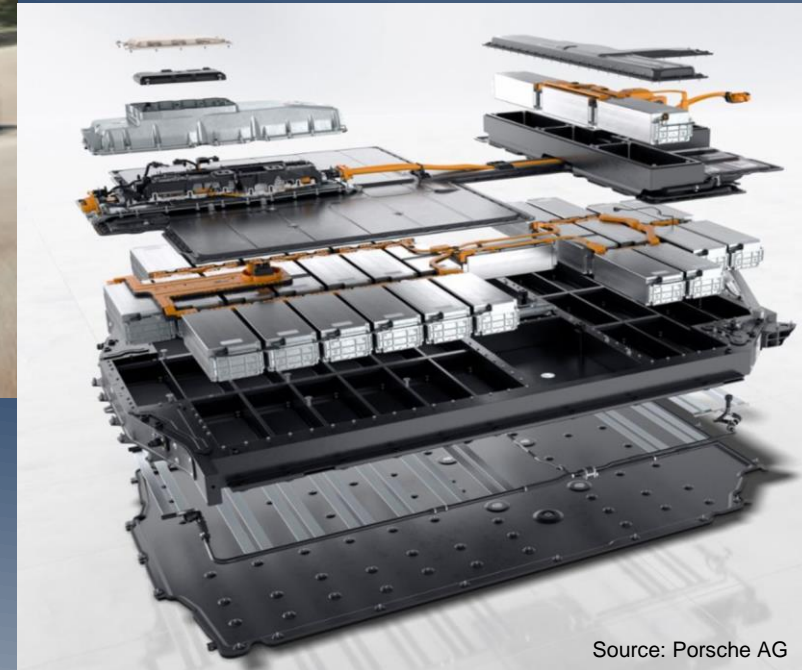


Source: Bild (Taycan-Forum)

0-100 km/h: < 3,5 s

Range: > 500 km

Charging Time: 100 km / 4 min



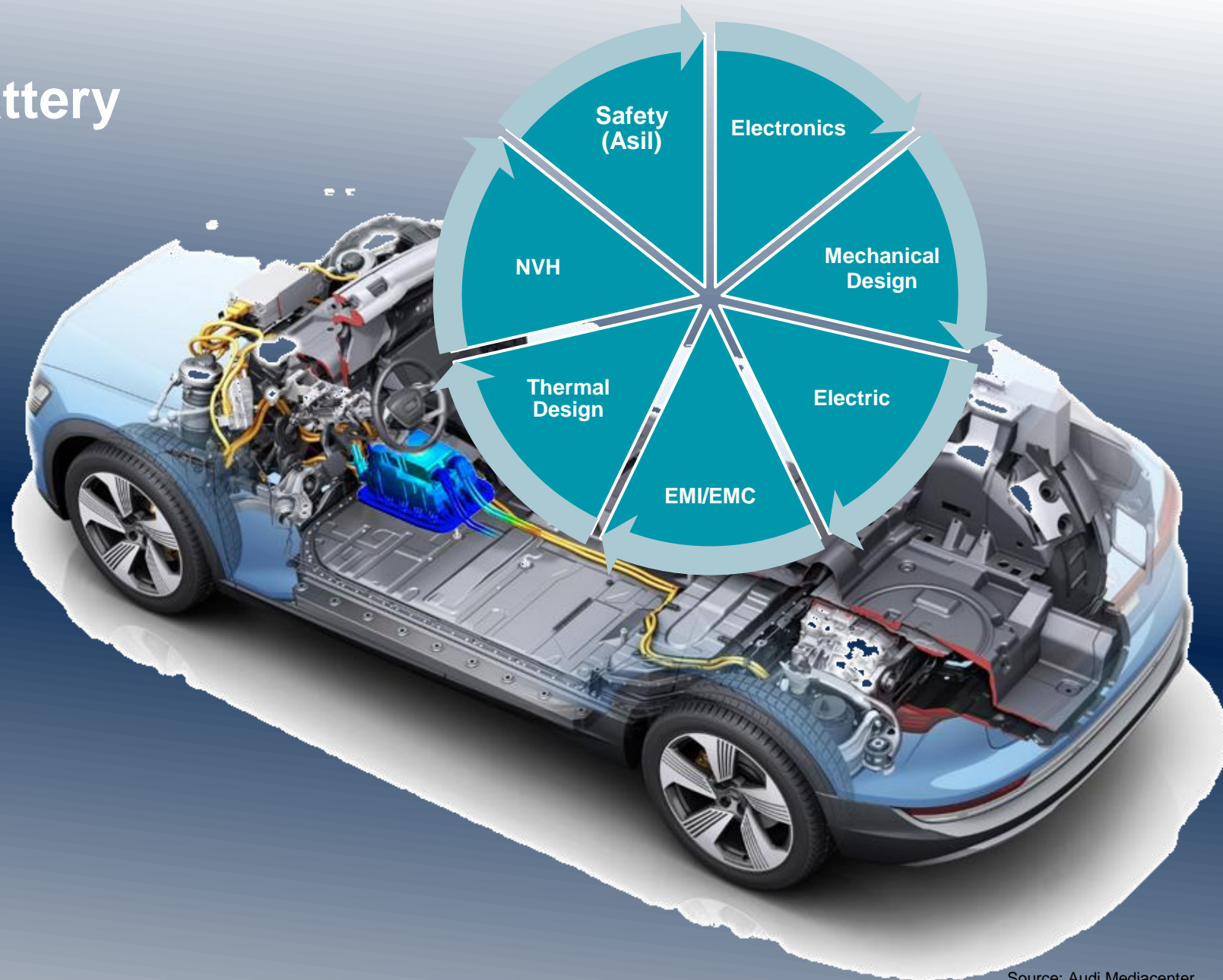
Source: Porsche AG

High-Performance HV-Battery

Key development aspects

Depth of added value

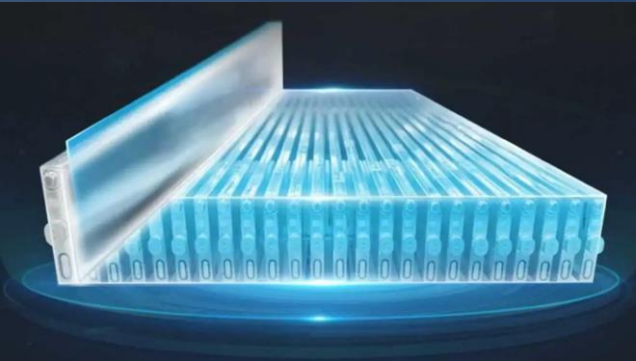
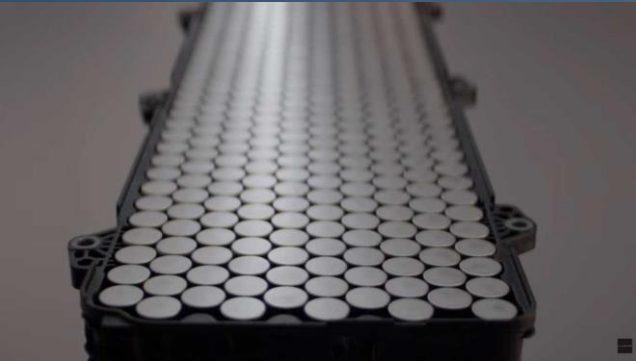
- Concept development
- Validation, testing
- Series development
- Industrialization
- Production
- Spare part service
- Recycling



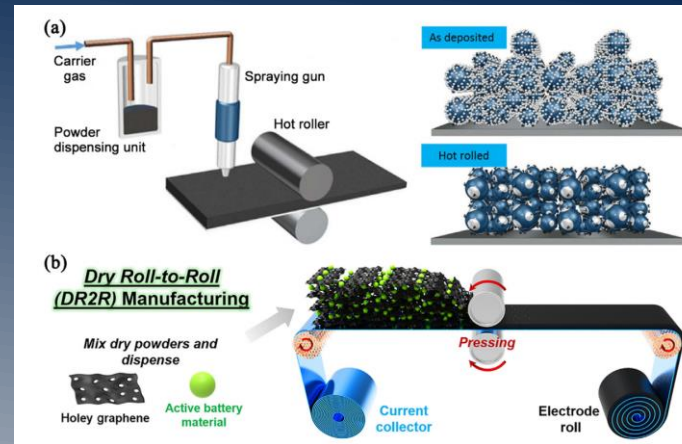
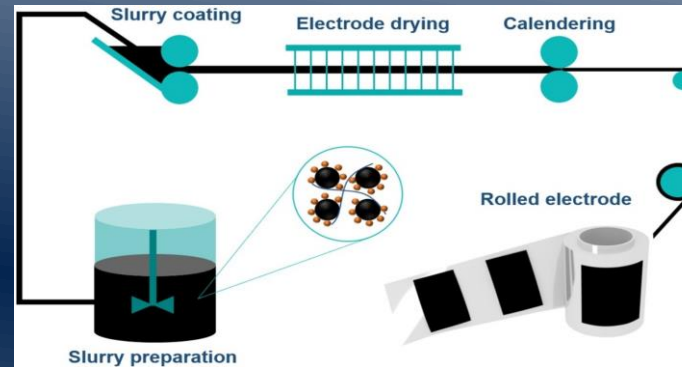
Source: Audi Mediacenter

Future Trends for High Performance EV Batteries

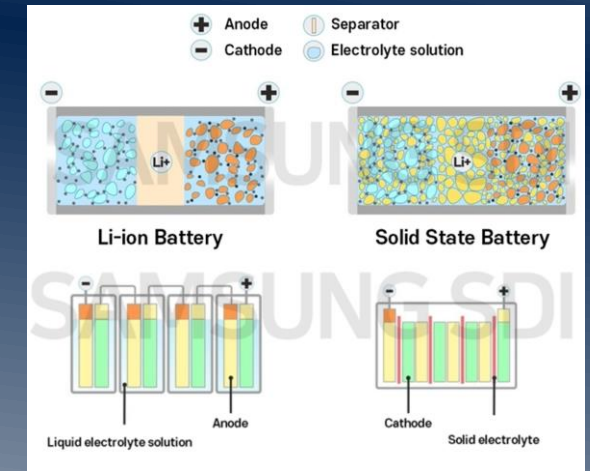
System/Cell Design



Process

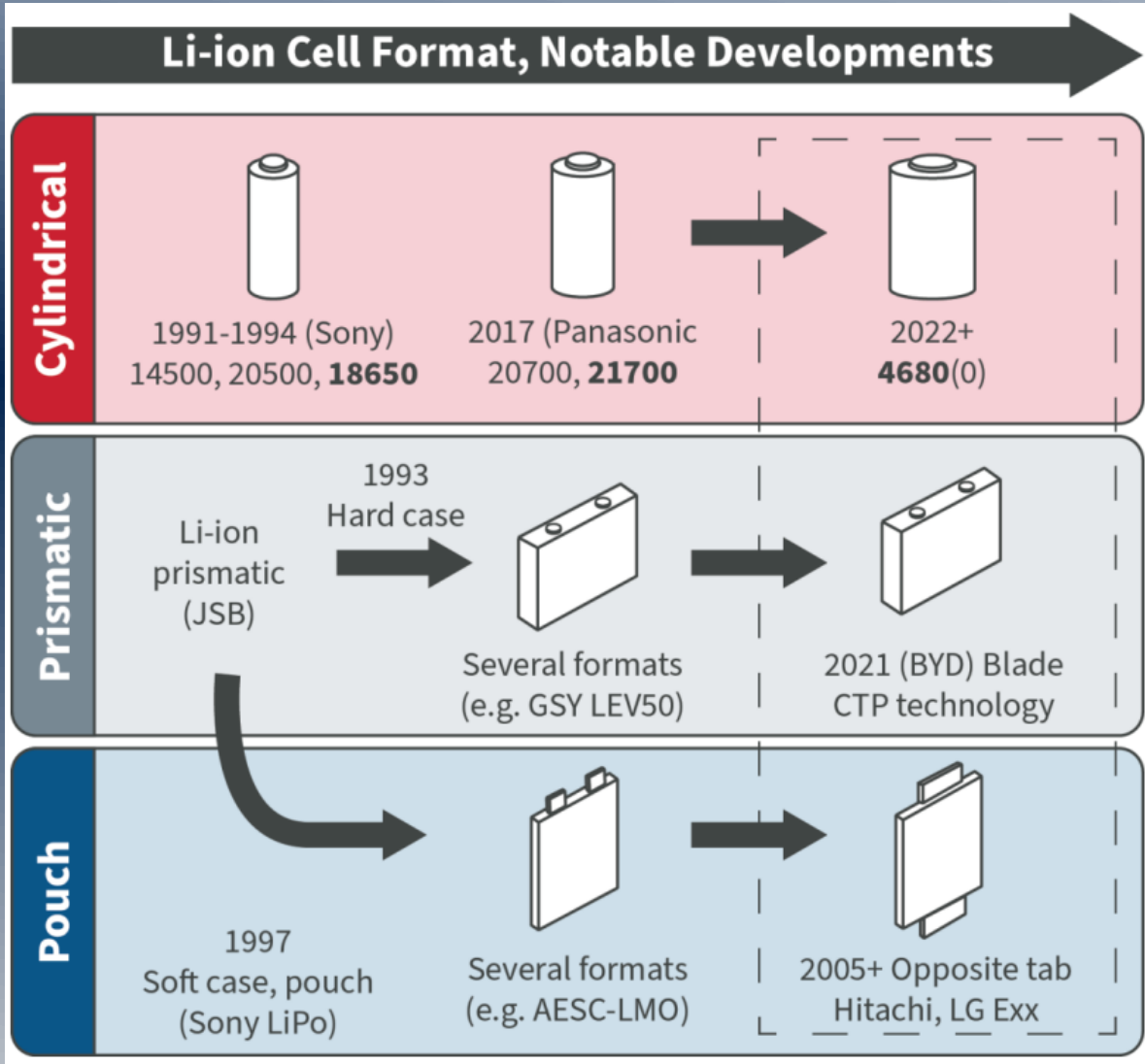


Chemistry



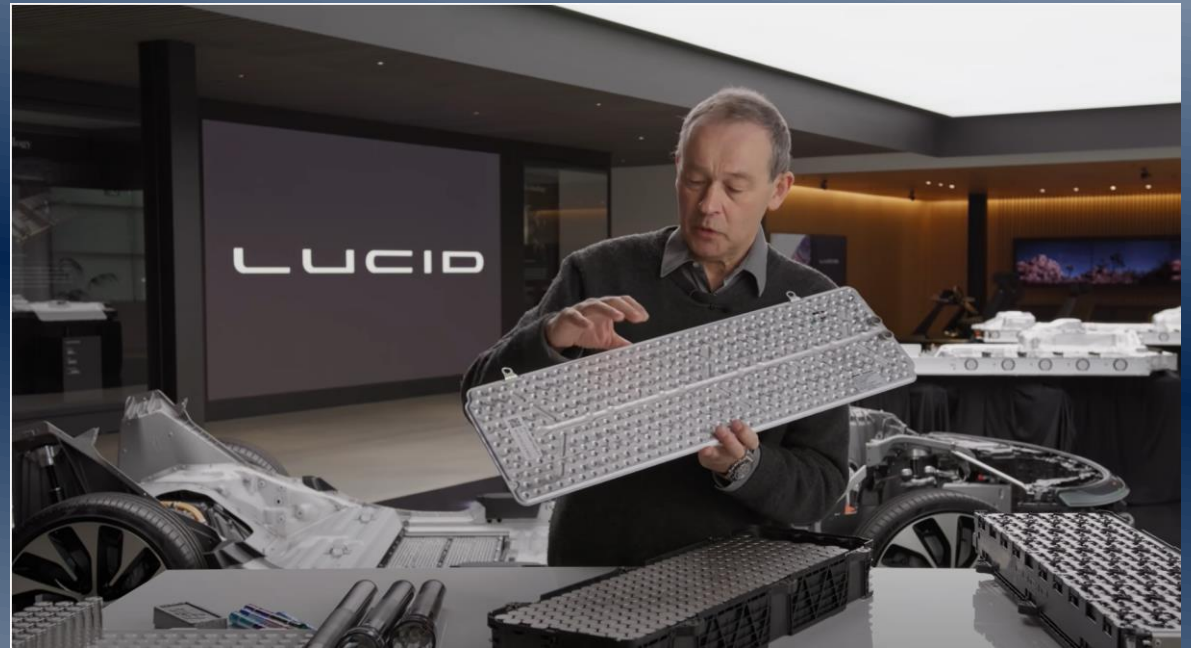
Sources: Lucid, BYD, CATL, Samsung SDI, Advanced electrode processing of lithium ion batteries: A review of powder technology in battery fabrication H. Liua,b, X. Chengc, Y. Chongc...

Battery Cell Format Development and System Design



Source: Vendigital

Battery Pack | Tech Talks | Lucid Motors
Peter Rawlinson, CEO



<https://www.youtube.com/watch?v=2aDyjJ5wj64&t=1412s>

Poll No 2 –What is a preferred future cell format? Please select one.

Go to www.menti.com and use the code 6218 8794

Future Cell Format

 Mentimeter



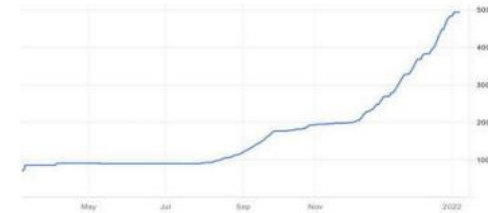
Raw material costs push up market price of LiB

Year on Year Change in Costs of the Battery Cell Cathode Materials of Tesla Model 3 (60 kWh)

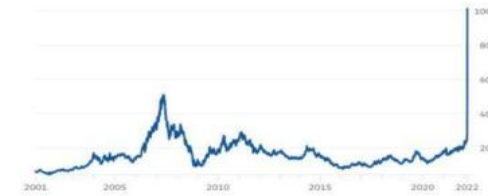


	Amount	Cost March 2021	Cost 8 th March 2022
	38.8 kg Lithium Hydroxide	465 USD 12 USD/kg	2440 USD 63 USD/kg
	47.5 kg Nickel	785 USD 16.5 USD/kg	4750 USD 100 USD/kg
	2.7 kg of Cobalt	145 USD 55 USD/kg	210 USD 80 USD/kg
Total:		1395 USD per Vehicle	7400 USD per Vehicle

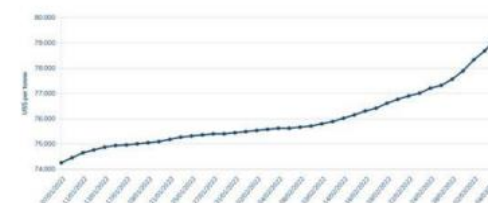
Price Charts



LITHIUM
+425% in 12 months



NICKEL
+500% in a few days

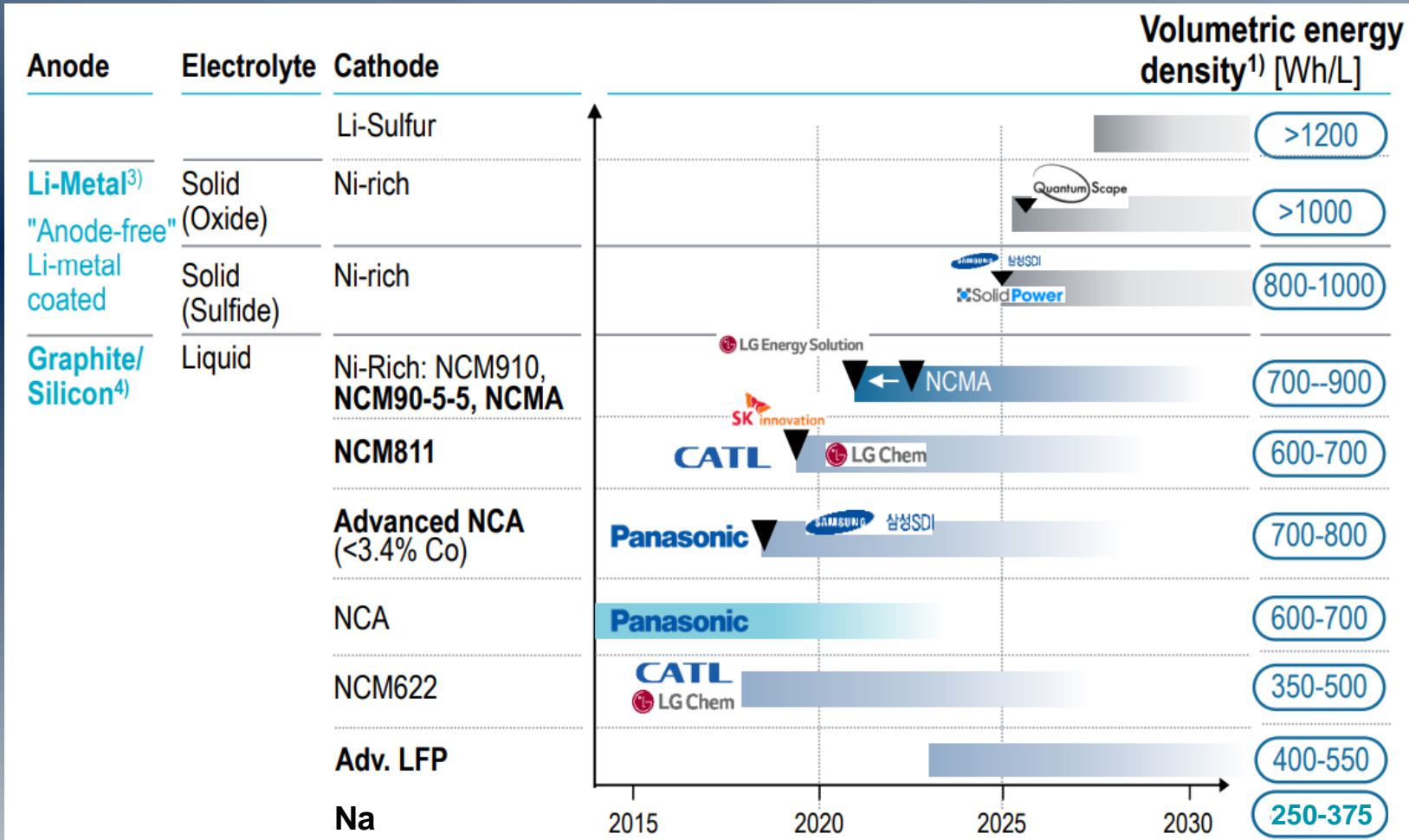


COBALT
+45% in 12 months

Source: ACC, F. Carranza

Future Trends for High Performance EV Batteries

Technology progress in chemistries

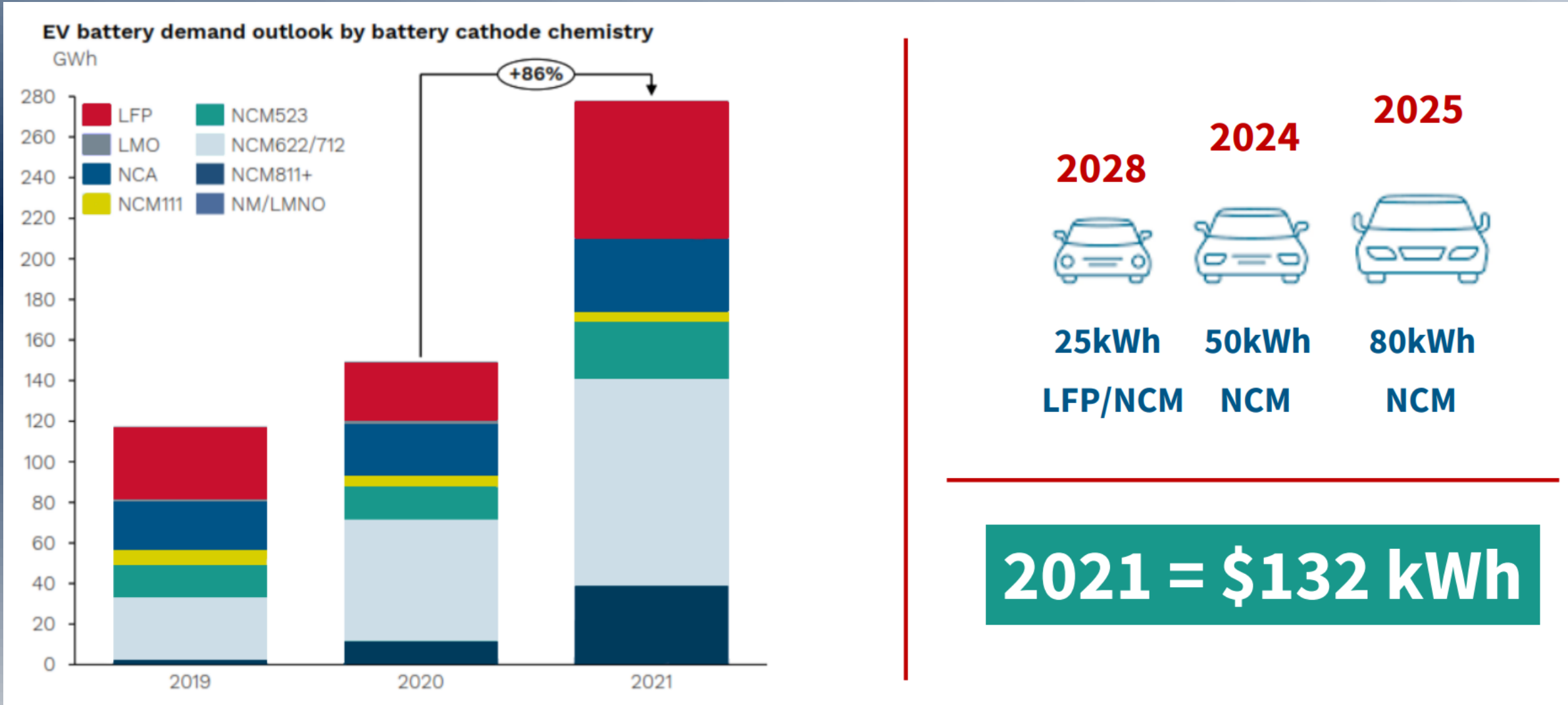


Next-Gen Technology (> 2025)

- 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 increase energy density on system level

Source: Roland Berger

Battery Chemistries Development



2021 = \$132 kWh

Source: Vendigital

Battery Chemistries Development - Solid-State

LUX Research SOLID STATE BATTERY TECHNOLOGY LANDSCAPE

1 OXIDE-BASED ELECTROLYTE

From top to bottom: corporates, small-medium enterprises, research institutes,

Panasonic	muRata INNOVATOR IN ELECTRONICS	HONDA	BOSCH	dyson
NGK	ilika	QuantumScape	ProLogium	University of Colorado Denver
UNIVERSITY OF MICHIGAN				

2 SULFIDE-BASED ELECTROLYTE

From top to bottom: corporates, small-medium enterprises, research institutes,

TOYOTA	FUJIFILM	Hitz 日立産研株式会社	LG Chem	IDEMITSU
SAMSUNG ELECTRONICS	LISKEN	ZEON	MITSUBISHI GAS CHEMICAL	HONDA
Solid Power	POLY PLUS		UNIVERSITY OF MARYLAND	

3 POLYMER-BASED ELECTROLYTE

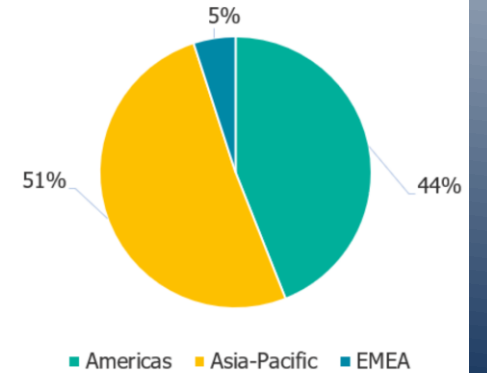
From top to bottom: corporates, small-medium enterprises, research institutes,

LG Chem	HITACHI	Wildcat Discovery Technologies	APB	BlueSolutions
Hydro Québec	SE	Rensselaer	DEAKIN	

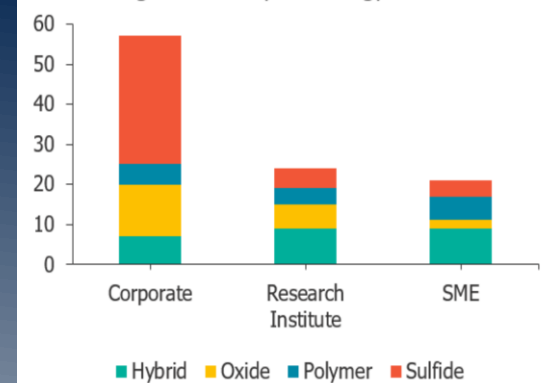
4 HYBRID-ELECTROLYTE

LG Chem	Panasonic	GS YUASA	BASF	Ampere
SAKUI	ProLogium	Ampcera	Hydro Québec	KIST Korea Institute of Science and Technology
Caltech				

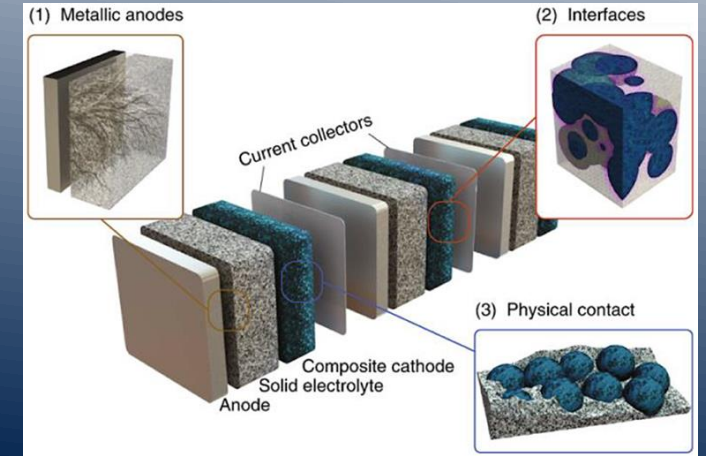
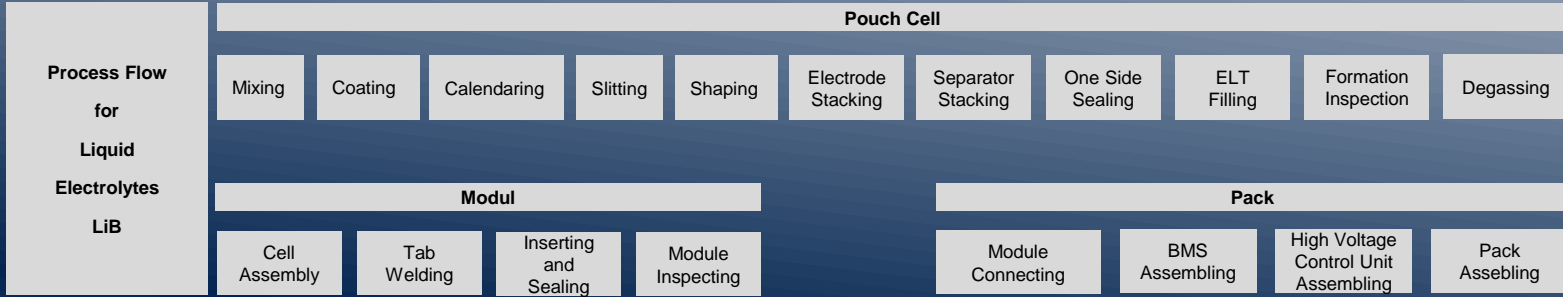
Solid-State Battery Players
By region



Solid-State Battery Players
Count of organizations by technology

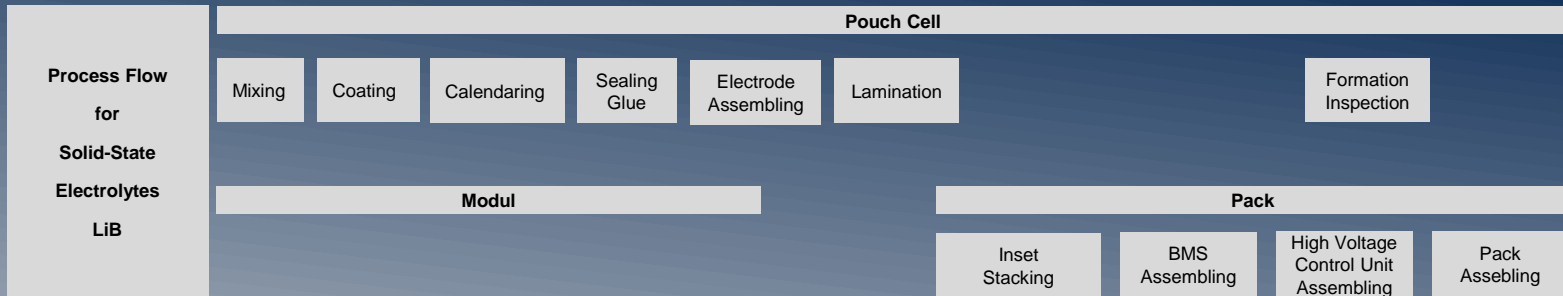


Battery Chemistries Development - Solid-State



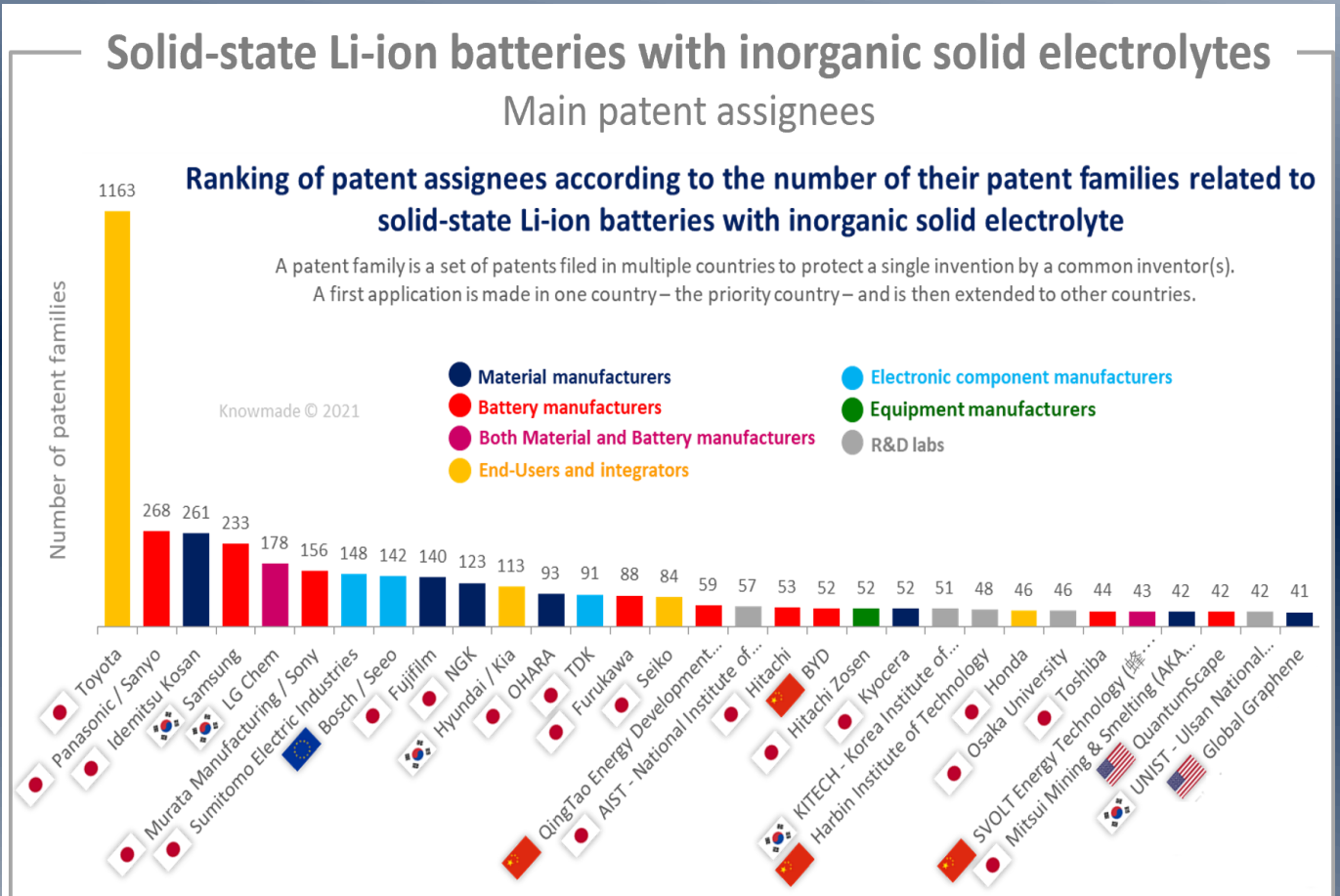
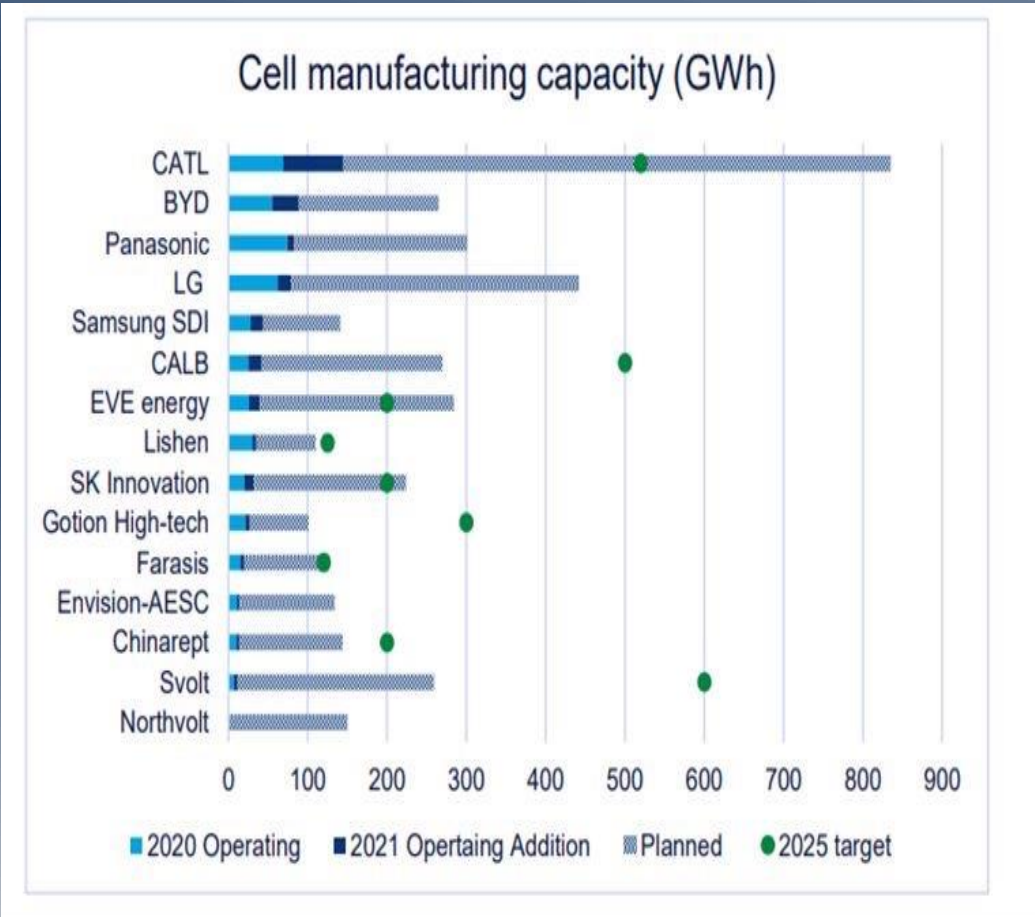
Process Simplification > 40%

Cycle Time > 200%



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....

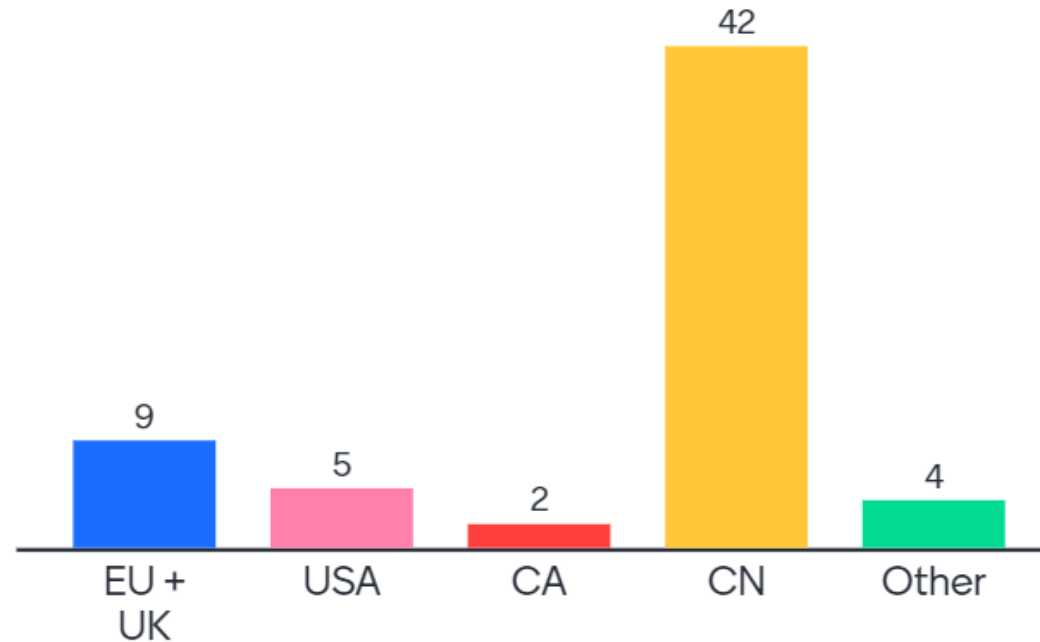
Solid-State Li-ion Batteries Patent Landscape 2021



Sources: Know Made

Poll No 3 – Which country / region will be the future leader in materials for Li batteries? Please select one.

Future Battery Supply Chain - Materials



CANADA'S BATTERY SUPPLY CHAIN WILL POWER THE ELECTRIC VEHICLE REVOLUTION

- **Nickel:** Quebec, Newfoundland and Labrador, Manitoba and Ontario
- **Lithium:** Quebec, Alberta and [Ontario](#)
- **Graphite:** Quebec, Manitoba and [Ontario](#)
- **Cobalt:** Quebec, Ontario and Newfoundland and Labrador
- **Manganese:** Nunavut
- **Molybdenum:** British Columbia
- **Rare Earth Elements:** [Saskatchewan](#) and the Northwest Territories



AdvEn Inc.

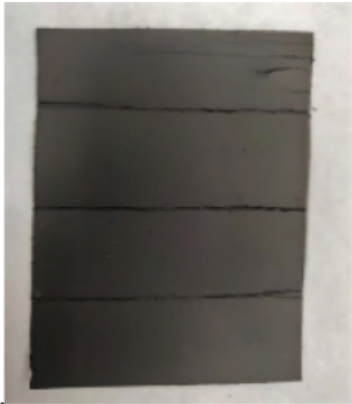
<https://adven-industries.com/>

CANADA'S BATTERY SUPPLY CHAIN WILL POWER THE ELECTRIC VEHICLE REVOLUTION

AdvEn ESAC Overview

ESAC Strength and Durability

Standard Slurry
Coating Technology



Cracked
electrode film
after folding

Competitor
Coating Technology



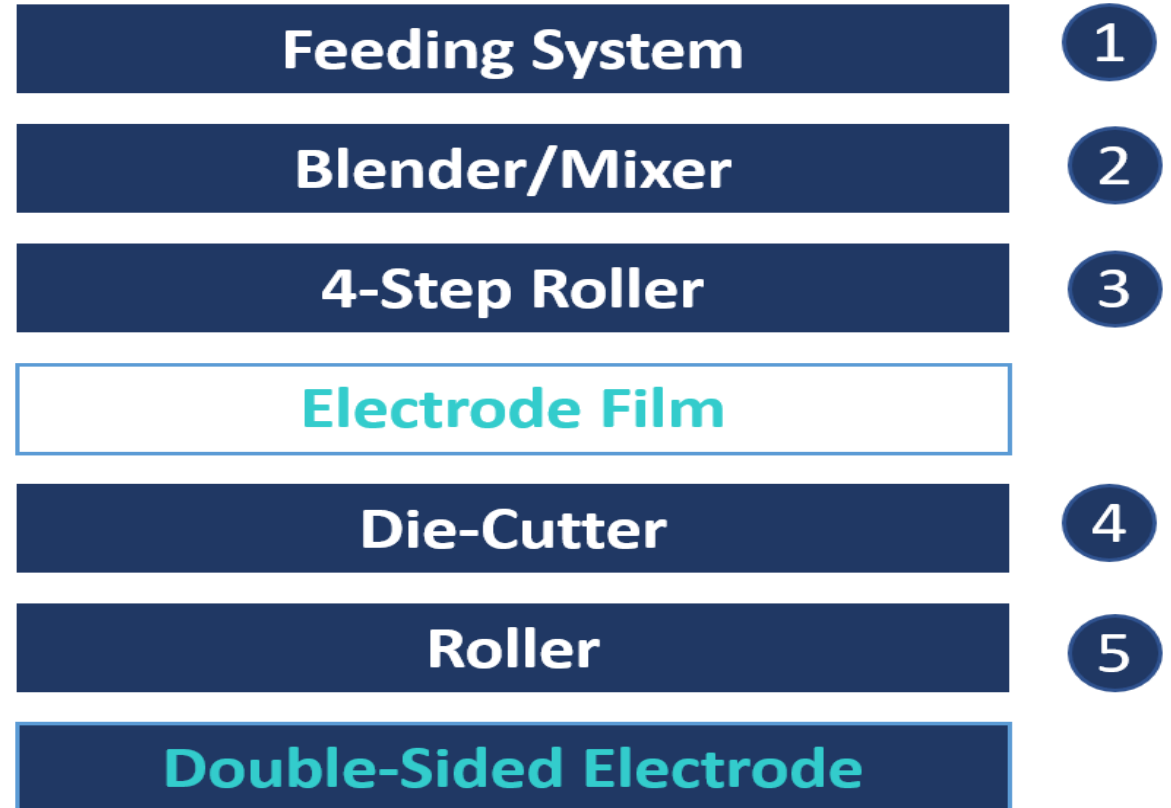
Damaged
electrode film
after folding

AdvEn ESAC
Technology



Un-damaged
electrode film
after folding

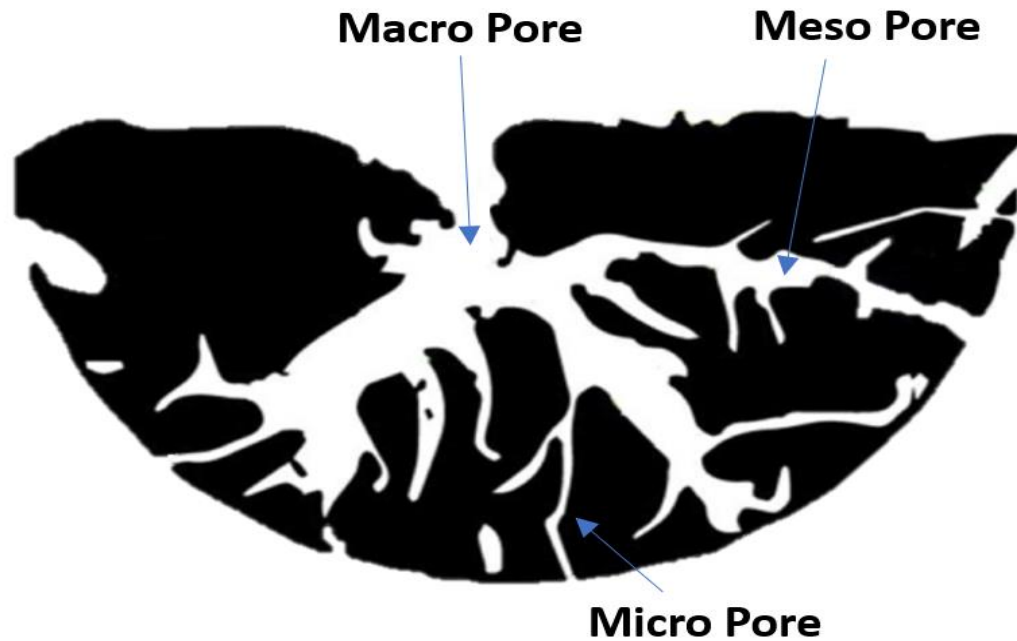
ESAC Process



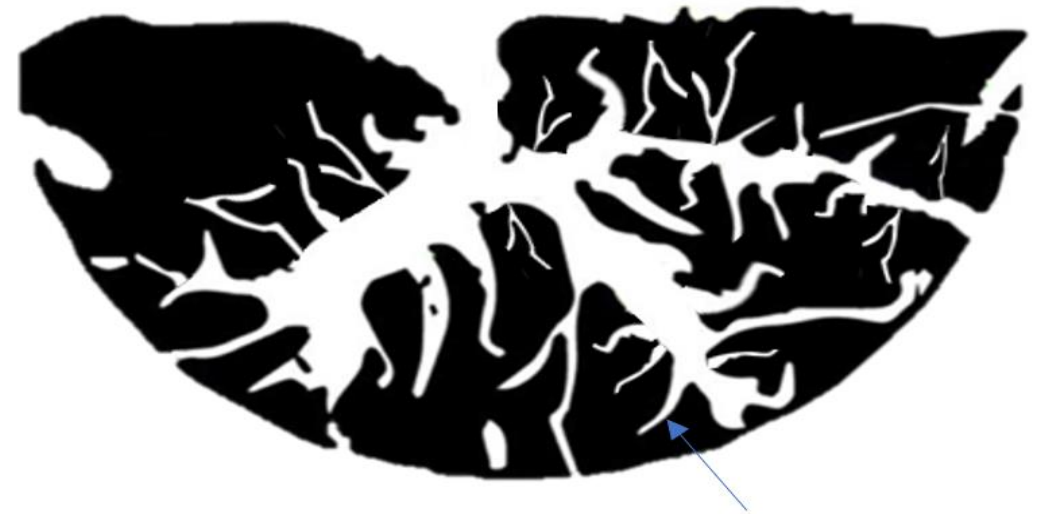
CANADA'S BATTERY SUPPLY CHAIN WILL POWER THE ELECTRIC VEHICLE REVOLUTION

AdvEn ASAC Overview

Conventional Activated Carbon



AdvEn ASAC



ASAC has significantly greater "Micro Pore" volume

Future Trends for High Performance EV Batteries

Requirments for high performance green battery innovations


What	Innovations	Who
Fast Charging 350 kW+	New Cell Design and Chemistries, Thermal Design	Cell Supplier, OEM, Infrastructure
Range 500 km+ (100 kWh+)	New Cell Design and Chemistries, Integration	Cell Supplier, OEM, Tier1
Lifespan, Degradation	New Cell Design and Chemistries, Thermal Design, Data & Model	Cell Supplier, OEM
Safety (Thermal runaway)	New Cell Design and Chemistries, Data & Model, Thermal Design	Cell Supplier, OEM
Design for remanufacturing	Integration	OEM, Tier1
Design for recycling	Integration	OEM, Tier1
Data & Model driven approach	Data acquisition and Product and Production Digital Twin, Analytics	Cell Supplier, OEM, Tier1



**Automotive
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EUROPE

2-4 May 2022 | INFINITY Munich

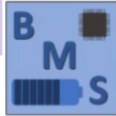
LinkedIn



Grzegorz (Greg) Ombach
Head of Disruptive R&T ♦ Senior Vice President ♦ at Airbus Group
Airbus Group Inc. | INSEAD


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<https://www.linkedin.com/in/grzegorz-ombach/>



Battery Management Systems
Listed group

27,097 members



999+

[Invite connections](#)

[See all](#)

<https://www.linkedin.com/groups/1606827/>