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The Batteries Fuelling Global Light Vehicle Electrification

Powering the Transition to Carbon Neutrality

Kevin Riddell, Senior Manager, Powertrain Forecasting

September 15, 2022

The Battery Show

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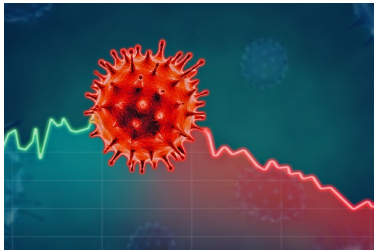
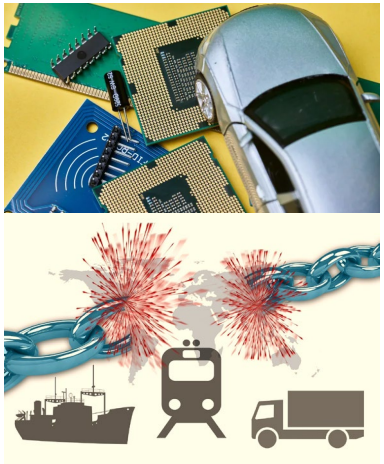
A World of Uncertainty



2020



2021

2022

Disruptors continue to add layers of risk to recovery pace

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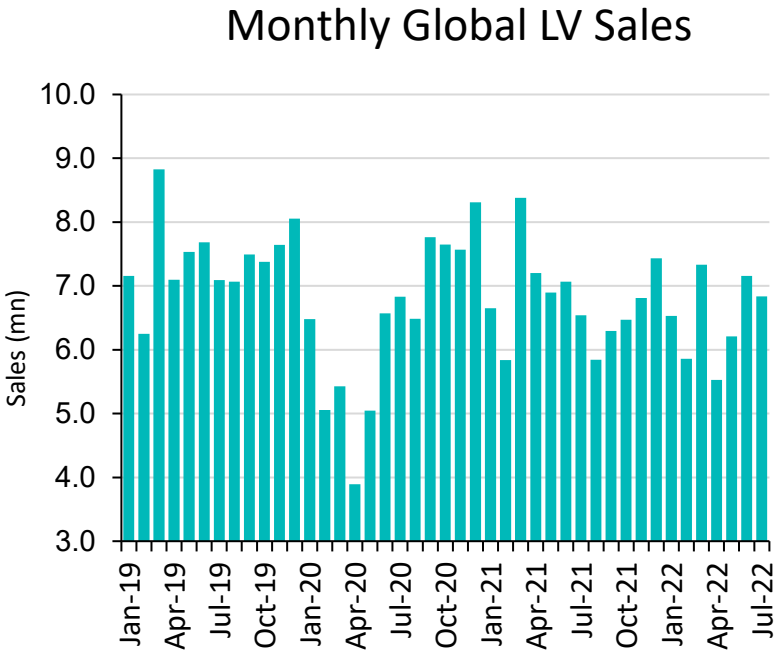
Global Demand for New Vehicles Is Strong



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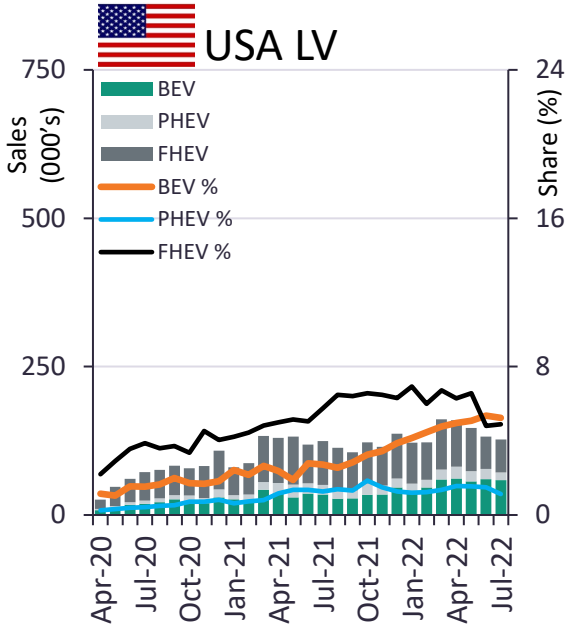
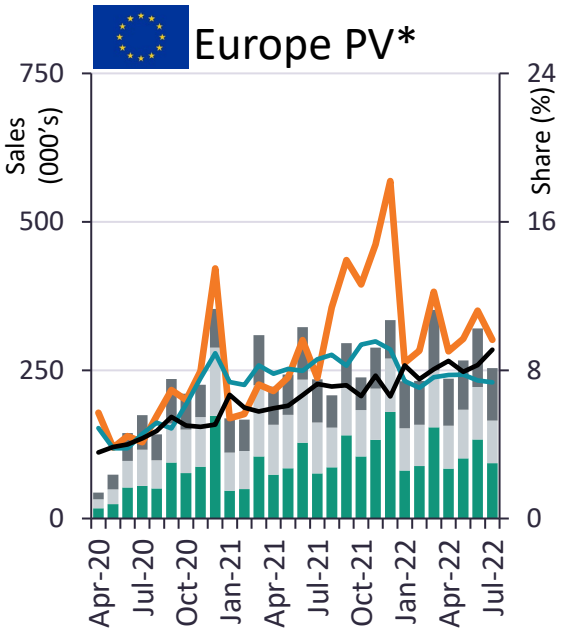
xEV Demand by Major Global Region

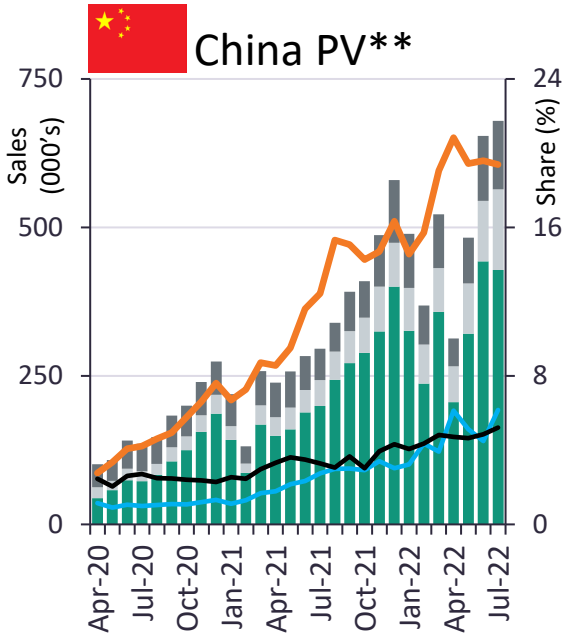
BEV, PHEV & FHEV markets



USA BEV YTD Jul 2022: +66%



EU BEV YTD Jul 2022: +30%



China BEV YTD Jul 2022: +112%

Source: LMC Automotive Global Hybrid & EV Bulletin
*pan-Europe; **wholesales

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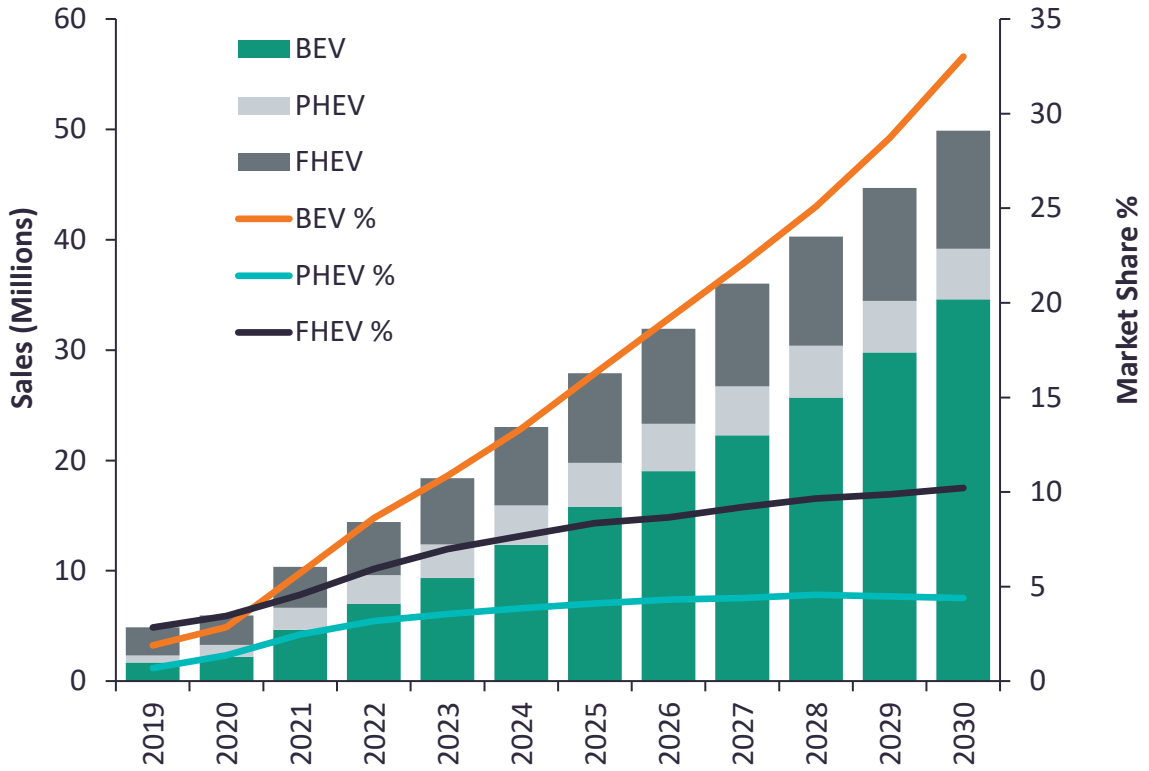
Global: Full Hybrid and Plug-In Electric Vehicle Outlook



- **Global** focus on reaching climate neutrality.
- Strong government investment supporting electrification transition.
- Strong regulatory influence in China, Europe and US.
- Developing economies expected to focus on xHEV.

Source: LMC Automotive Global Hybrid & EV Forecast

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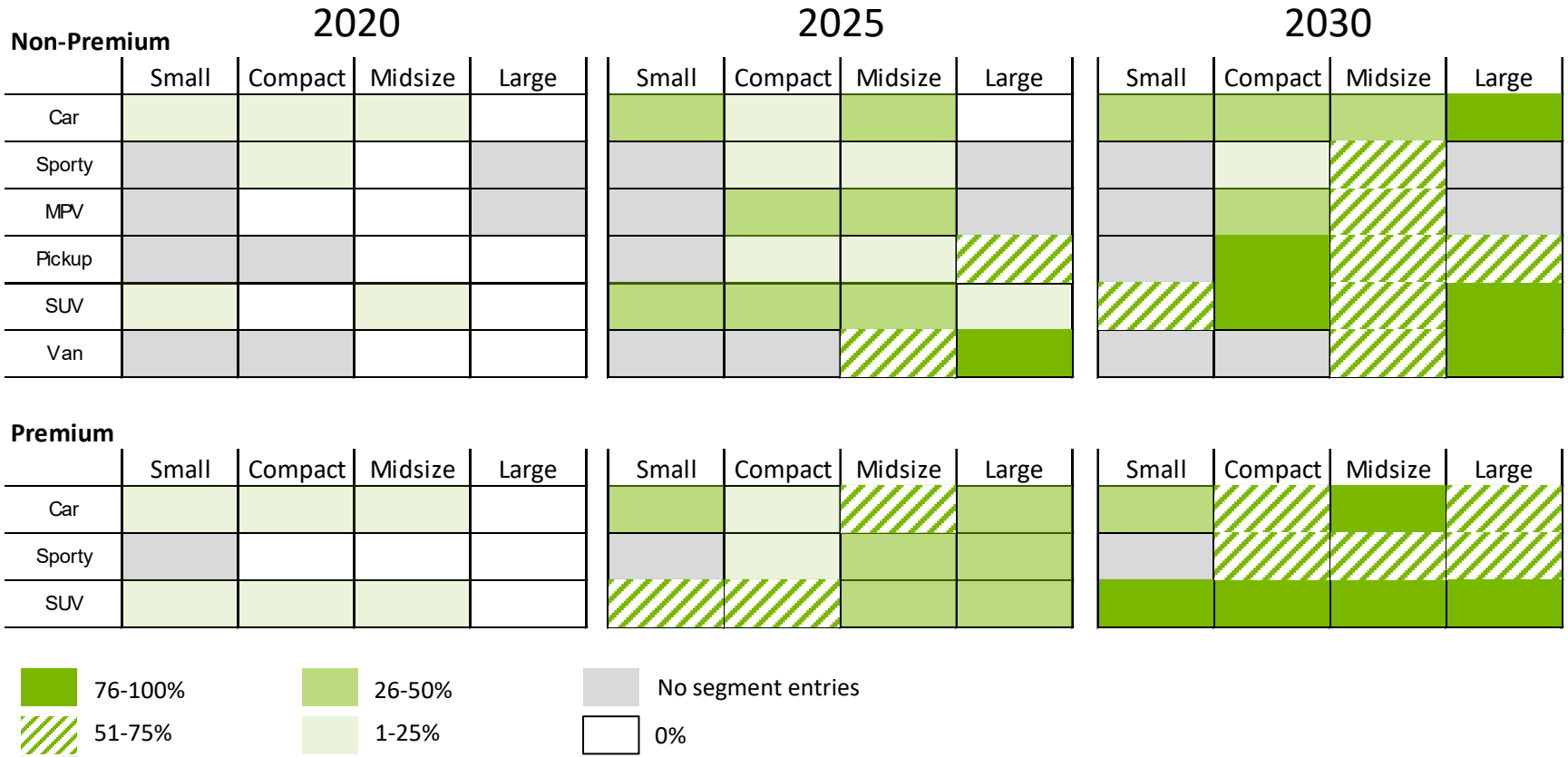
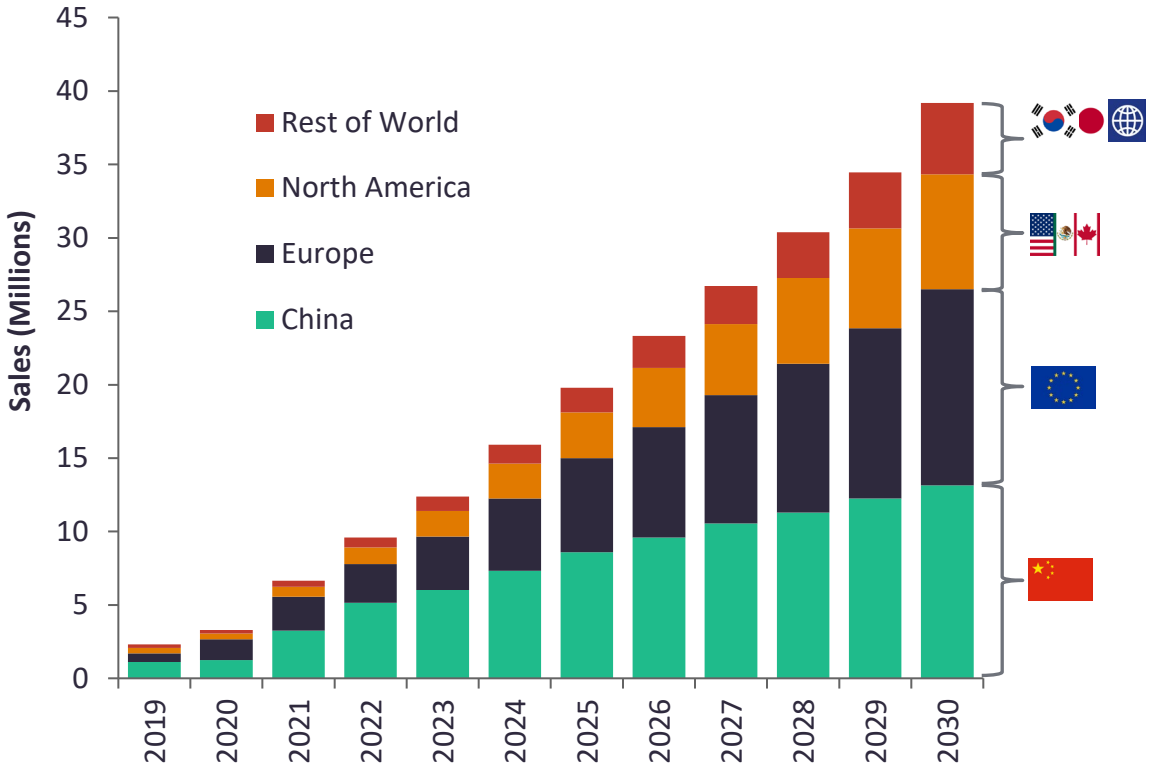
BEVs Are Steadily Increasing Segment Coverage

Expected BEV availability in the US by segment



Source: LMC Automotive

Plug-In Electric Light Vehicle Sales by Major Region



- China continues strong growth but changes in regulations toward FHEVs allow slower in PEV sales.
- In Europe strong CO_2 regulations expected to continue.
- Future EPA and California regulations expected to continue pushing PEV sales in the US and Canada.
- **In the near term subsidies are still important globally.**

Source: LMC Automotive Global Hybrid & EV Forecast

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Global Plug-In LV Production 2021

- BEV production tends to start in Automaker's home region, exporting to global markets.
- Import/export shifts will occur as non-domestic OEMs increase global BEV footprint.
- Chinese demand is the primary consumer of Chinese-built BEVs.

Source: LMC Automotive Global Powertrain Forecast

Global Plug-In LV Production 2027

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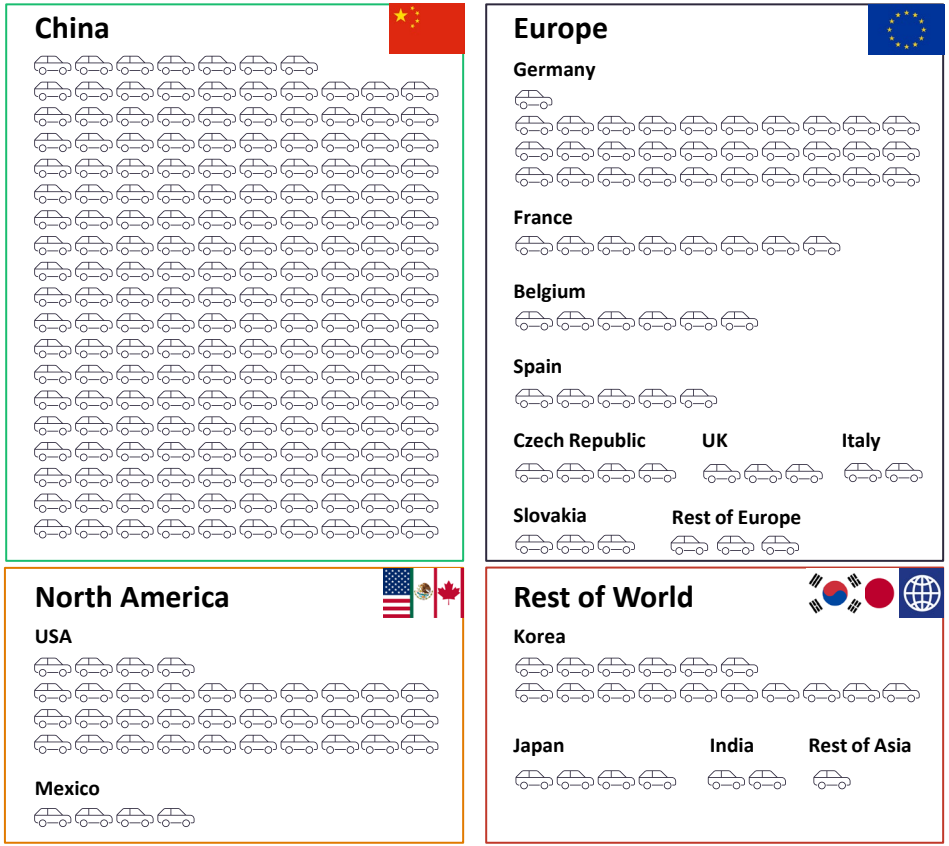
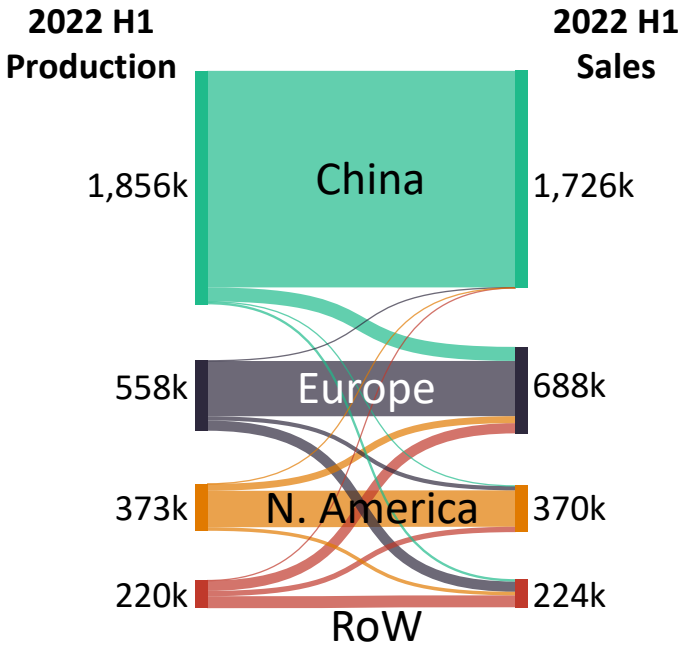
Source: LMC Automotive Global Powertrain Forecast

Global LV BEV Production in H1 2022: 3m units





Source: LMC Automotive, JATO, Manufacturers

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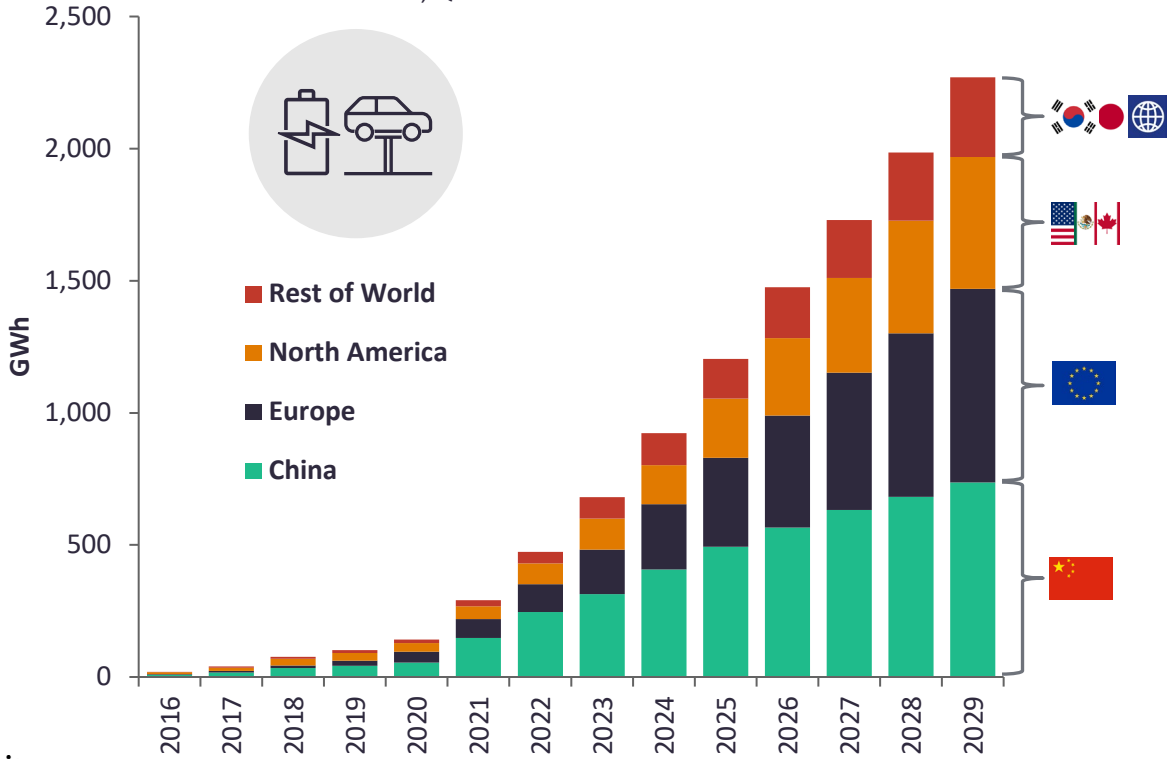
Global xEV Battery Demand Outlook

Battery fitment/installation in vehicle production

Shown: All xEV, Passenger cars + light commercial vehicles <6T
Source: LMC Automotive, Q1 2022



- China continues to be the largest battery consumer by capacity, but Europe and NA will grow quickly.
- In North America, larger vehicles will require larger batteries.
- BEVs account for 87% of total LV battery requirements and rising.

Source: LMC Automotive Global Powertrain Forecast

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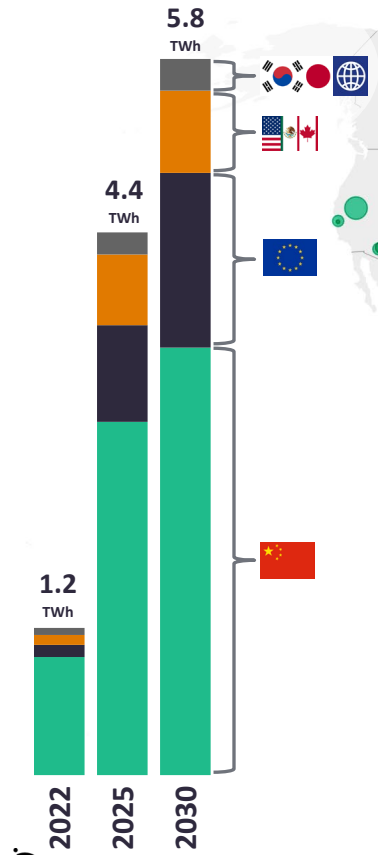
Comparison of Regional BEV Specifications

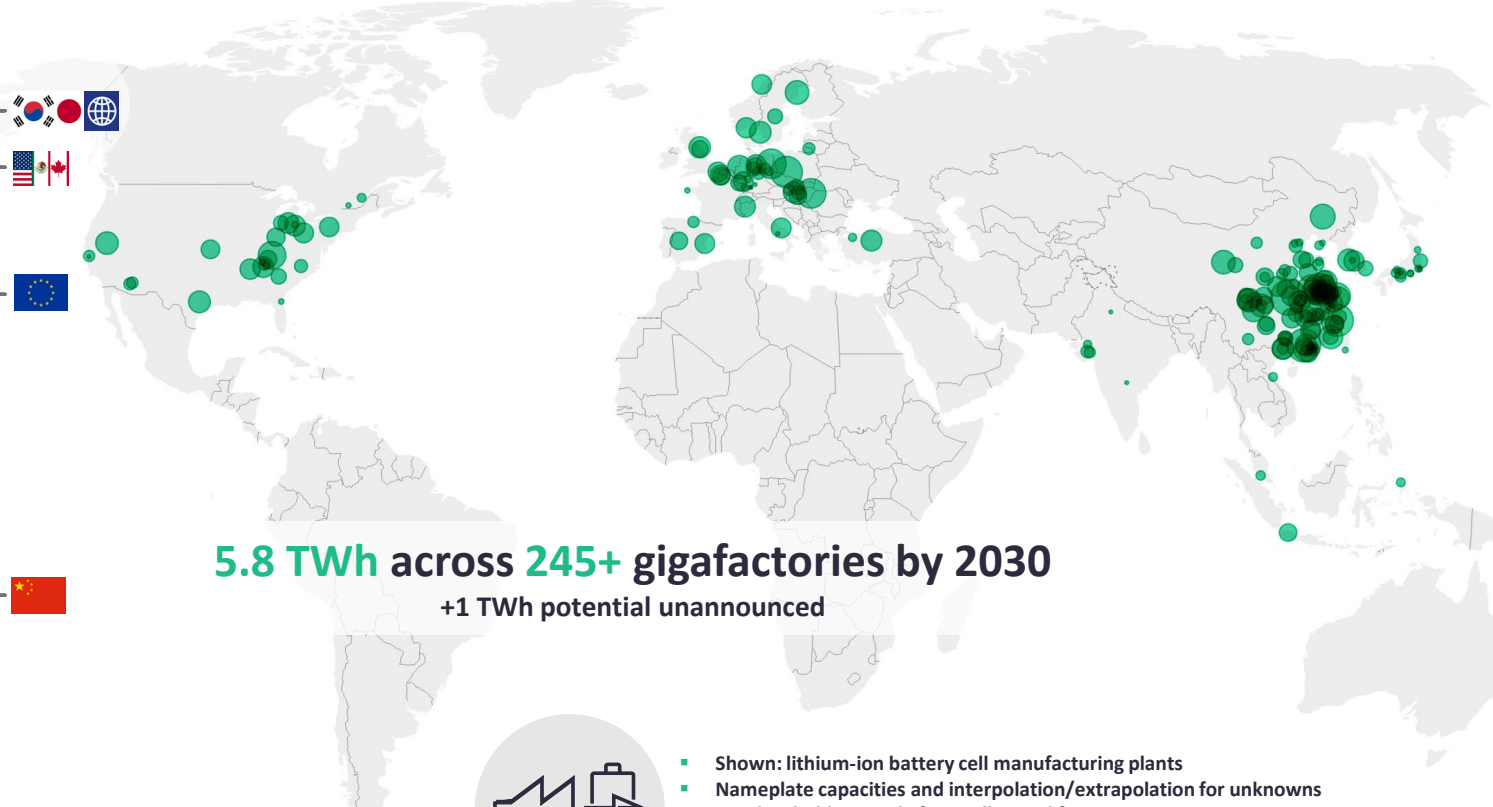
	China	Europe	N America
Average BEV Model Size	C-Segment	C-Segment	D-Segment
2021 Highest Production BEV	 Wuling Hongguang Mini	 Volkswagen ID.4	 Tesla Model 3
Average Battery Capacity 2021/2025	49 kWh / 62 kWh	59 kWh / 70 kWh	78 kWh / 96 kWh

Source: LMC Automotive, Manufacturers

Li-ion Battery Cell Manufacturing Capacity Plans

As of Q2 2022





5.8 TWh across 245+ gigafactories by 2030

+1 TWh potential unannounced

- Shown: lithium-ion battery cell manufacturing plants
- Nameplate capacities and interpolation/extrapolation for unknowns
- No placeholders made for unallocated future capacity
- Not shown: prospective projects, battery module/pack assembly plants
- Source: LMCA Global Light Vehicle Powertrain Forecast Q2 2022

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Regional Li-ion Battery Cell Gigafactory Projects

Overcapacity/underutilisation from overly ambitious plans

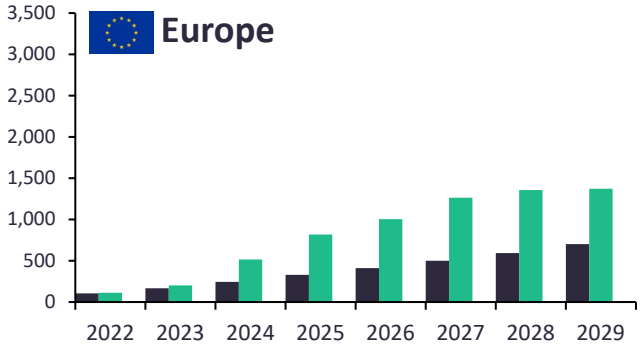
DEMAND FROM xEV

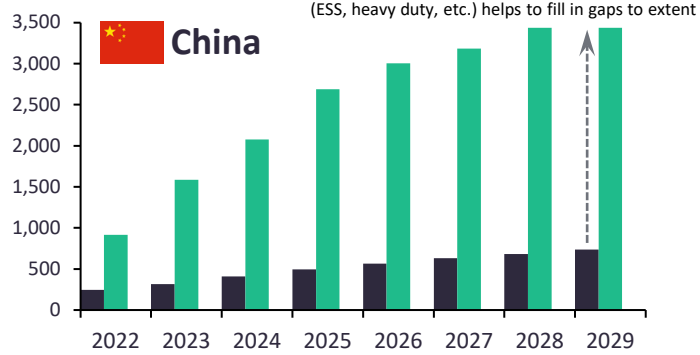
Battery fitment in vehicle production
(passenger cars & light commercial <6T)
in GWh based on LMC forecast as of Q2 2022

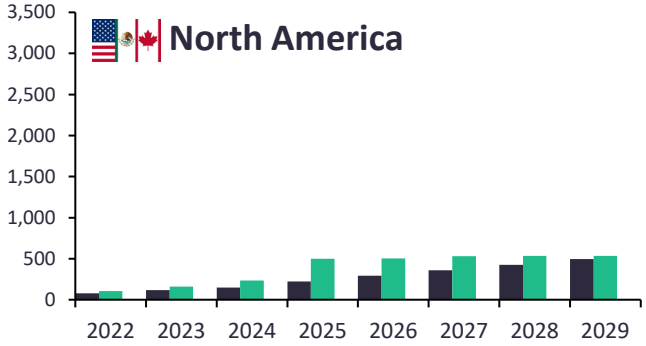
CAPACITY

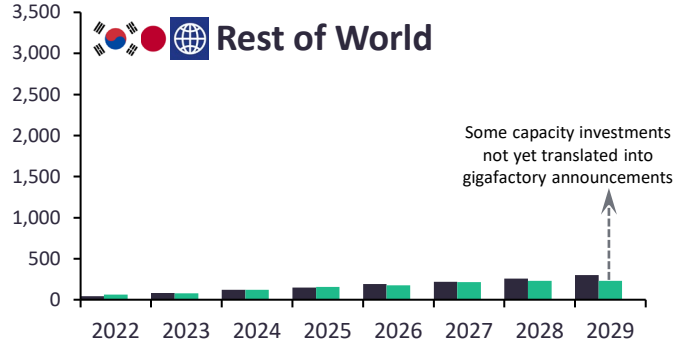
Cell production capacity in GWh
based on announcements as of Q2 2022

Does not include prospective projects that
have yet to be confirmed









Source: LMC Automotive Q2 2022

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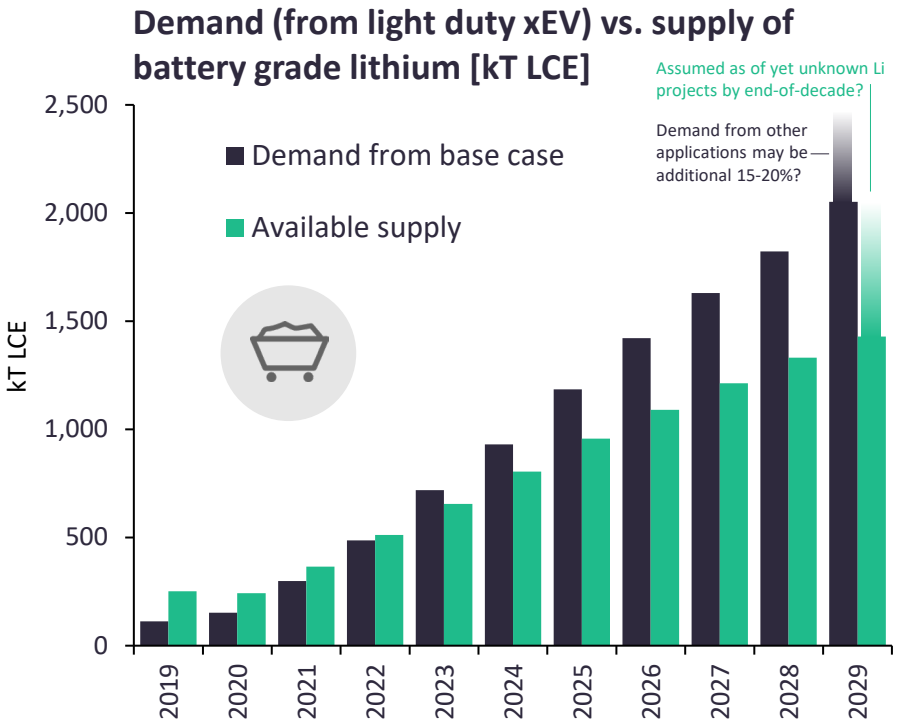
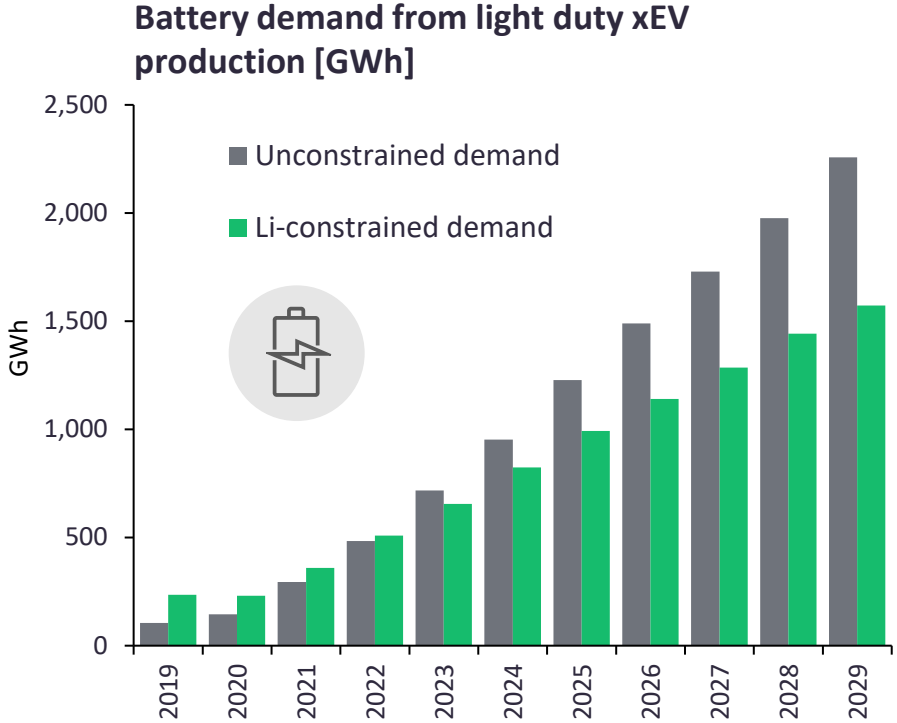
Battery-Grade Lithium Market Balance – One Scenario





- Demand derived from bottom-up battery chemistry forecast and estimates of total Li consumed from mine to cell (inc. yield losses).
- Supply derived from bottom-up assessment of operational, planned, and prospective Li assets, showing only likely expansions.
- Assumes no/minimal recycling. Demand from other applications not shown.

Source: LMC Automotive Q2 2022, GlobalData Mining

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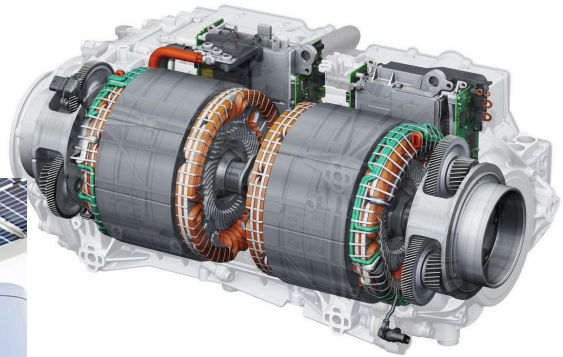
Automakers Investing Throughout the Ecosystem



Source: Ford, Audi, GM, SQM, Tesla

US Inflation Reduction Act

- Removes sales caps for qualified vehicles.
- Adds new vehicle price limits.
  - Vans/Pickups/SUVs: $80,000
  - Cars: $55,000
- Adds personal/household annual gross income limits of $150,000/$300,000.
- Point of sale redemption of credit.
- Vehicle must be assembled in North America.
- Scaling local critical material and battery component requirements.
- Restrict content from foreign entities of concern.
  - **No** Battery components after December 31, 2023
  - **No** critical materials after December 31, 2024

	Required NA Sourced Value	
Calender Year	**Critical Material***	**Battery Components**
2023	40%	50%
2024	50%	60%
2025	60%	60%
2026	70%	70%
2027	80%	80%
2028	80%	90%
2029	80%	100%

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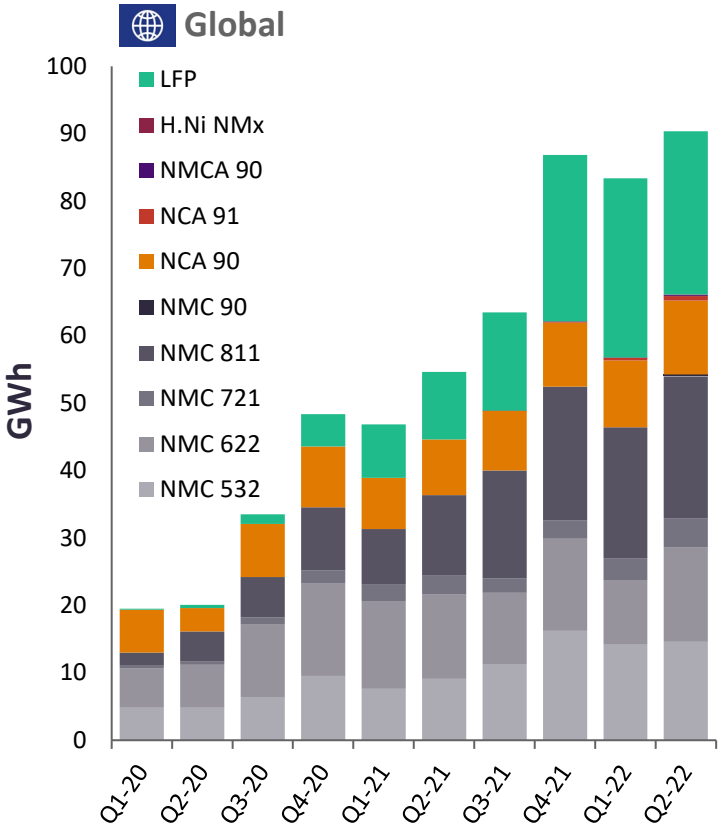
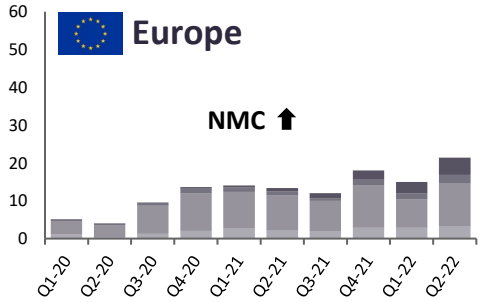
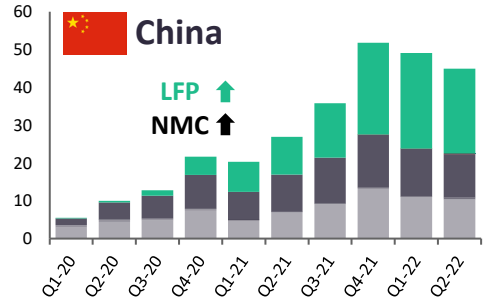
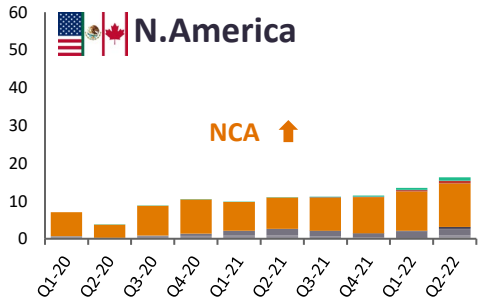
BEV Cathode Chemistry by Region – Current Status

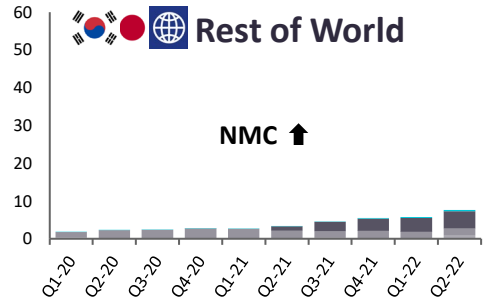


Shown: battery fitment/installations in pure battery-electric vehicle (BEV) production









Source: LMC Automotive Q2 2022

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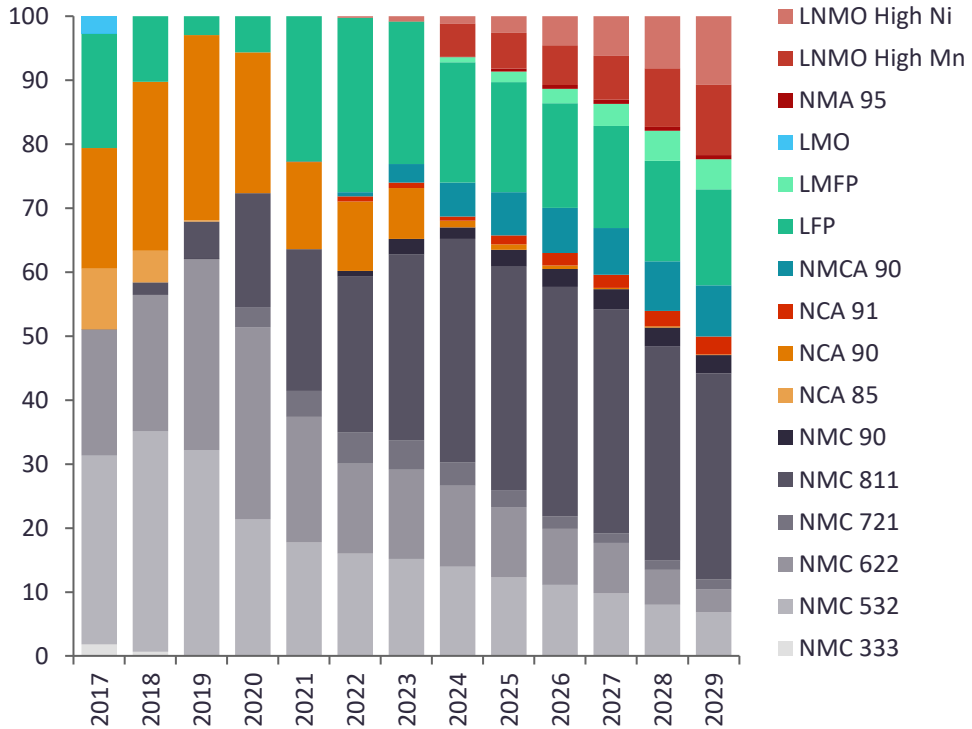
BEV Cathode Chemistry Outlook

Global share of cathode chemistries on GWh basis (%)
Shown: BEV only, Passenger cars + light commercial vehicles <6T



- **General trend towards high nickel/high manganese, and low/no cobalt.**
- Resurgence in LFP less profound this year; newly launched models with nickel-based chemistries to take a larger share.
- Mass adoption of LFP outside of China will not be until 2024/2025.
- LFP has potential for further growth but not fully baked into OEM roadmaps.
- North America is the cradle for new super-high-nickel chemistries. Range expectations are a major driver.
- Cobalt-free chemistries intended for volume segments, but considerable upside+downside risk.
- Legacy chemistries to continue in parallel until the end of vehicle lifecycles/renewal.

Source: LMC Automotive Q2 2022

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For any queries regarding my presentation, please contact me at:

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