McKinsey & Company

Will Upstream Supply Constraints Hamper the Growth of Lithium-Ion Battery Manufacturing in North America?

February, 2022

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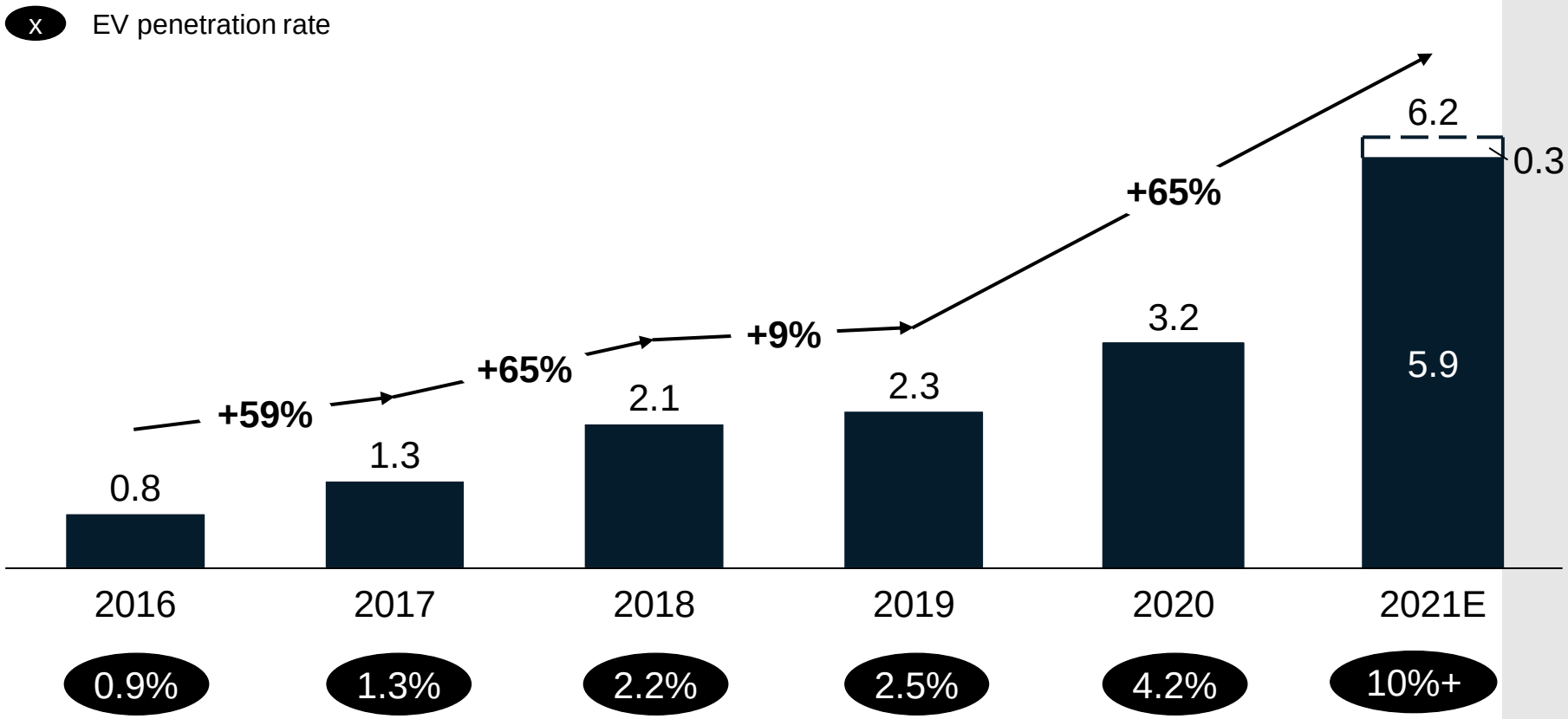
There was a massive increase in 2021 EV demand

Yearly global electric[1] light vehicle sales development
mn units



1. BEV and PHEV

Source: EV-volumes.com, IHS Markit (Light Vehicle Alternative Propulsion Forecast Jan 2021 2021 estimates based upon trend from EV-volumes data)

Key insights

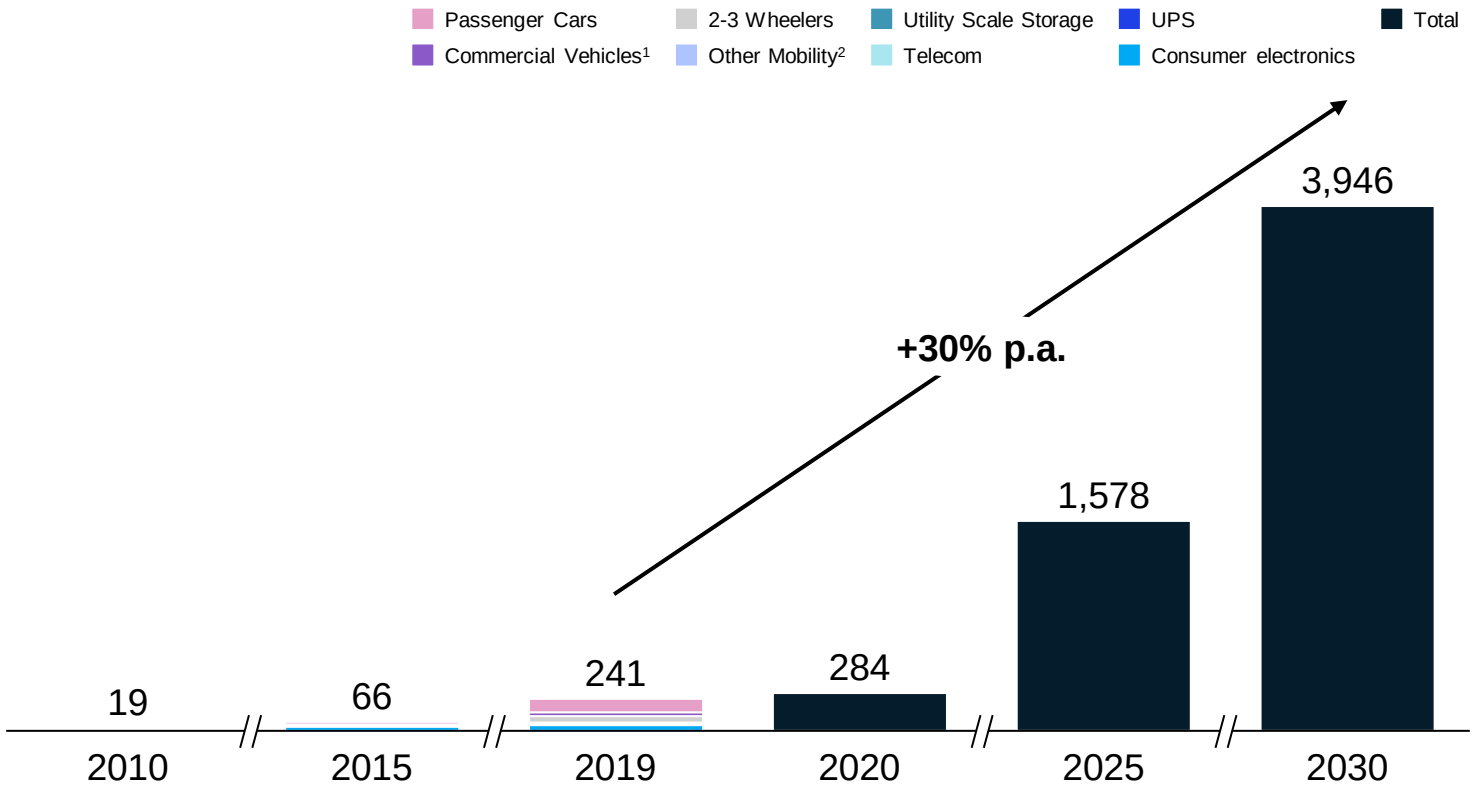
Electric vehicle sales reached approximately 6 mn units in 2021 almost doubling from 2020

EV's are gaining market share at an alarming rate, and growth has led to many OEM's saying they will end ICE production over the next decade.

Li-ion battery demand is expected to grow 30% p.a. in the coming years…

Driven by EVs, other road transport, and grid applications

Global Li-ion battery cell demand by sector, GWh



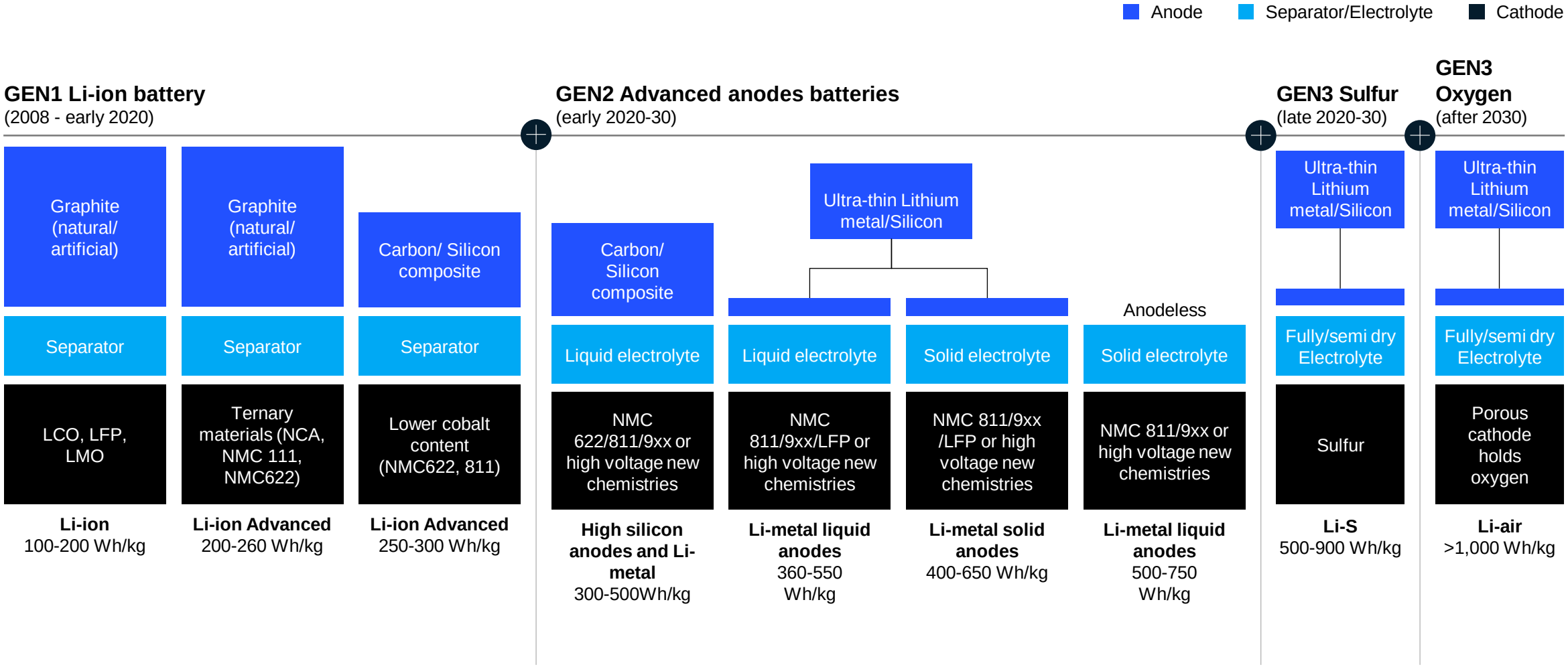
1. Includes trucks, buses, and LCVs
2. Includes Aviation, Marine, Consumer electronics, etc
3. Plug-in electric vehicles: BEV+PHEV
4. Total Cost of Ownership (TCO),

Source: IHS; WEF; McKinsey Battery Demand Model

- Total GWh annual demand expected to approach 4 terrawatts by 2030
- TCO[4] parity between electric and diesel is reached first for urban eBuses and light-duty eTrucks
- Grid battery storage is expected to increase with increasing shares of intermittent renewable electricity generation

We see battery chemistry evolving over three horizons

The scale-up of new generation batteries would not cause a strong change in the choice of raw materials

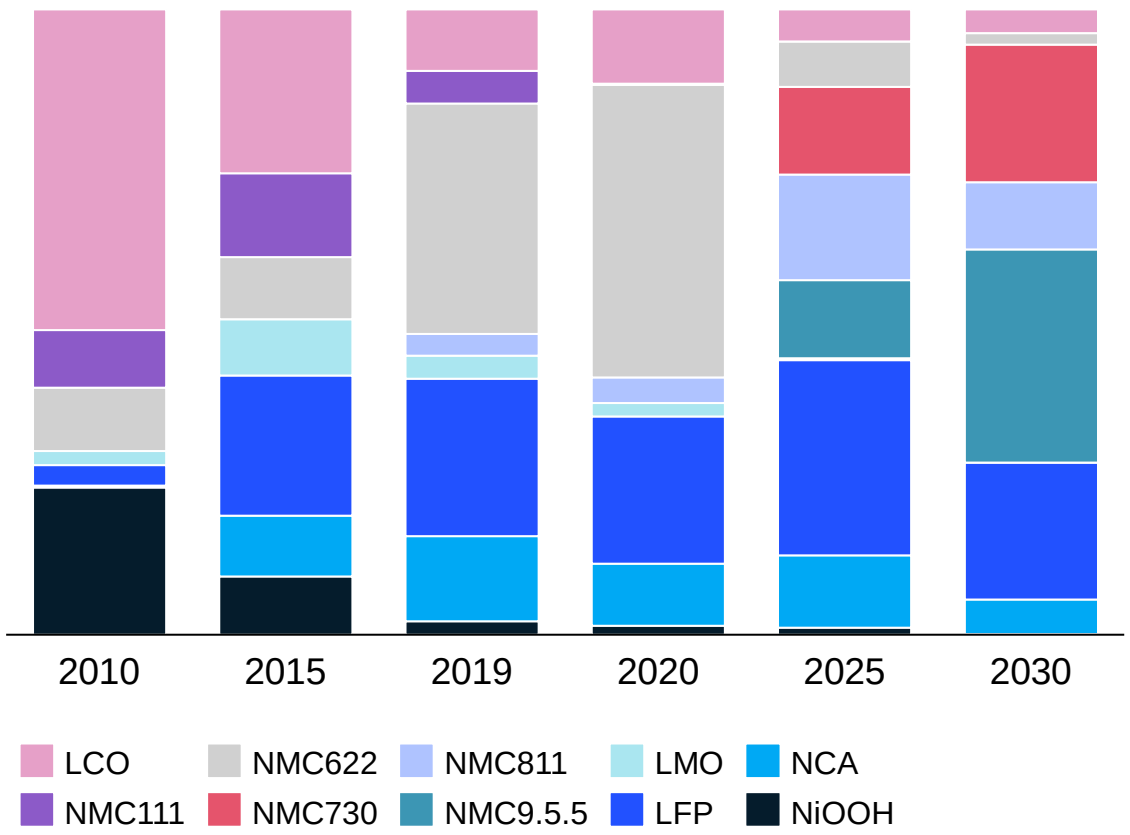


1. Very early stage reflexion
2. Based on 7-year contracts in average, last known supply order signed with Volkswagen in March 2021

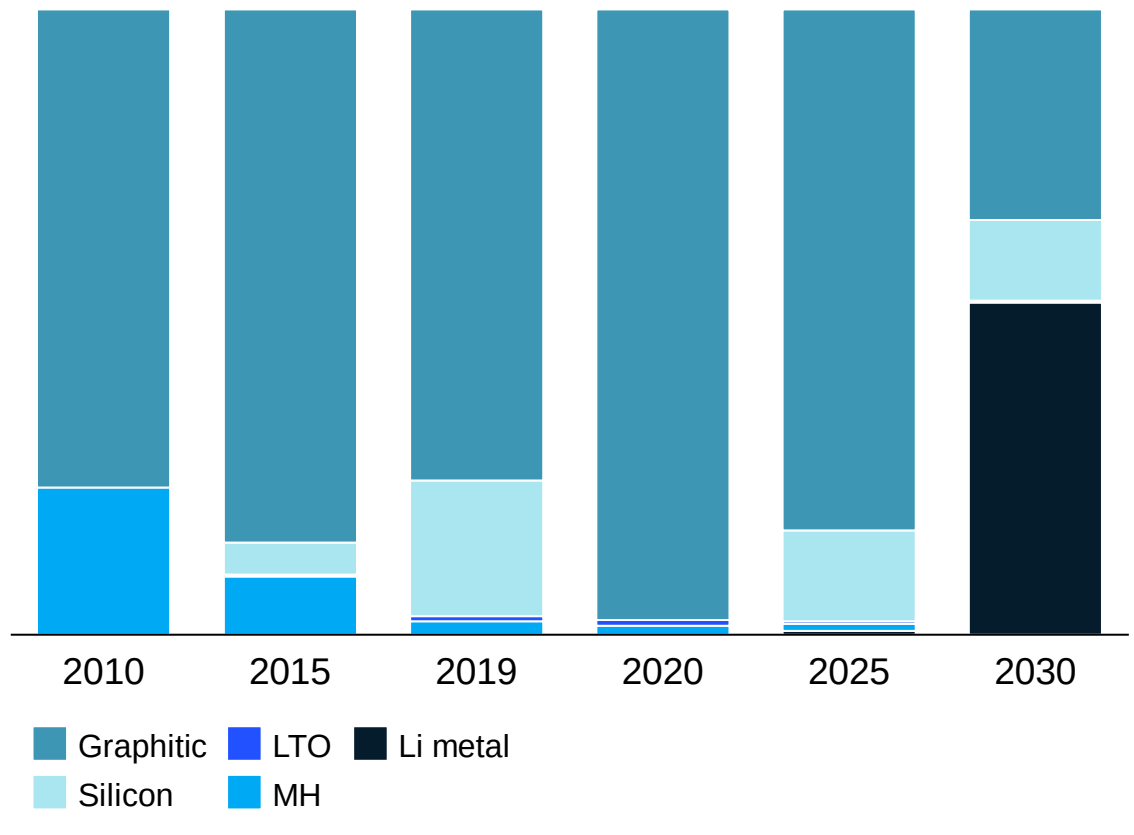
Source: Team analysis, Bernstein

Battery technology will branch out to many chemistries, with chemistries meeting various needs

Cathode Split, GWh

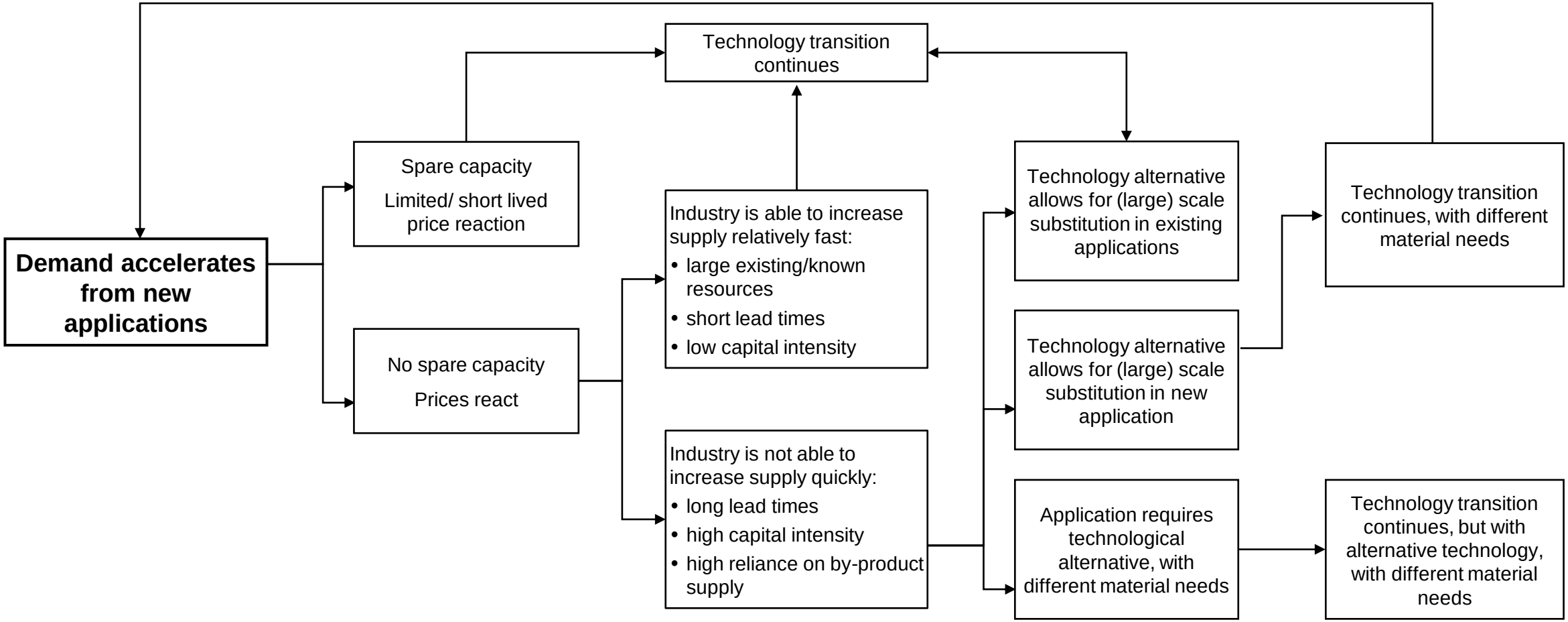


Anode Split, GWh



Source: McKinsey Battery Demand Model

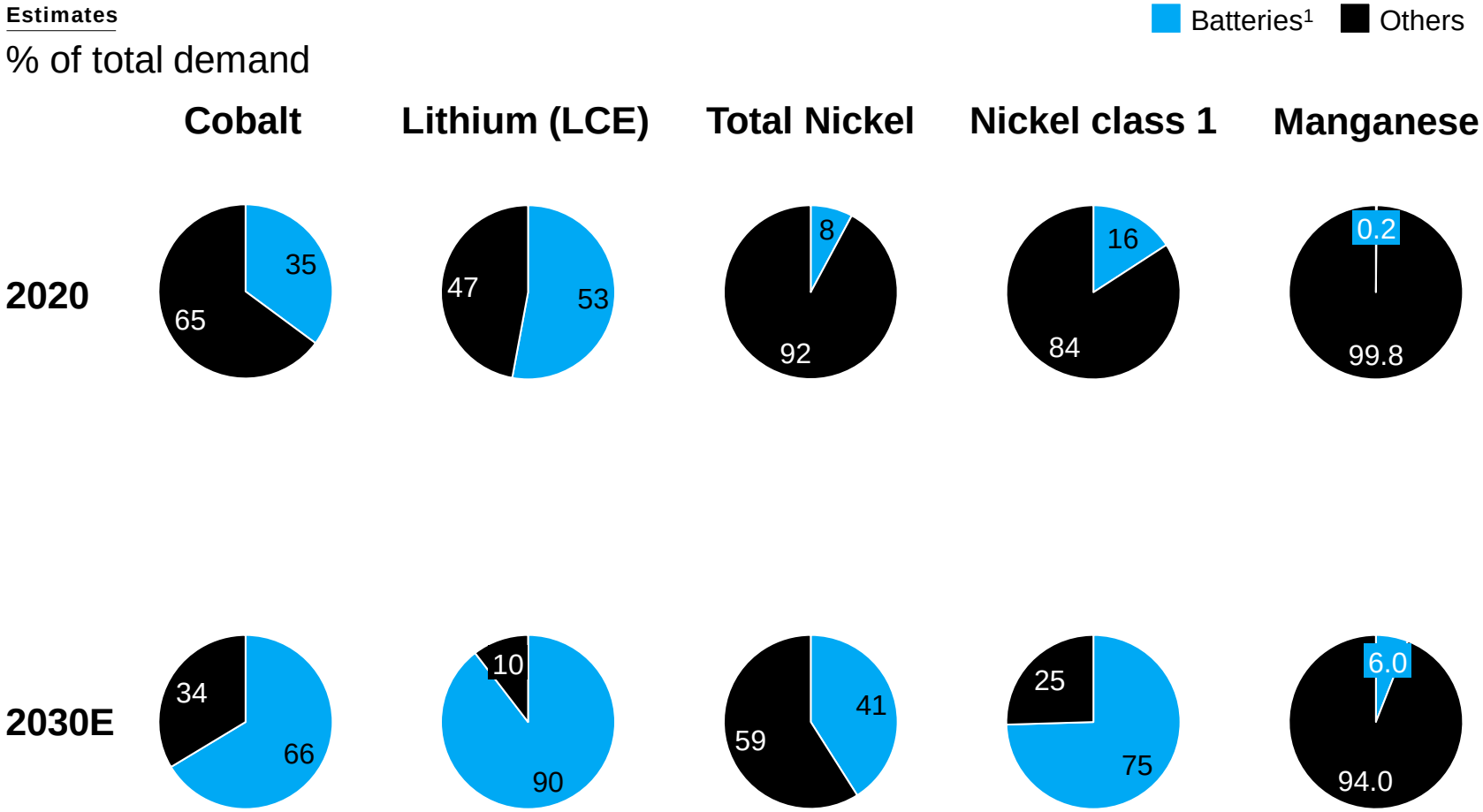
Supply, demand and price reactions will in fact lead to feedback loops, whereby we'll see a combination of supply reactions, technology shifts and material substitution



While pedic material tightness could occur, new and varied chemistries allow for EV growth

Estimates

% of total demand



1. Only considering Li-ion secondary batteries

Source:

Under our base and aggressive case EV growth scenas, while we could see short term tightness due to transitory mining and refining bottlenecks, longer term they will alleviate and not constrict growth.

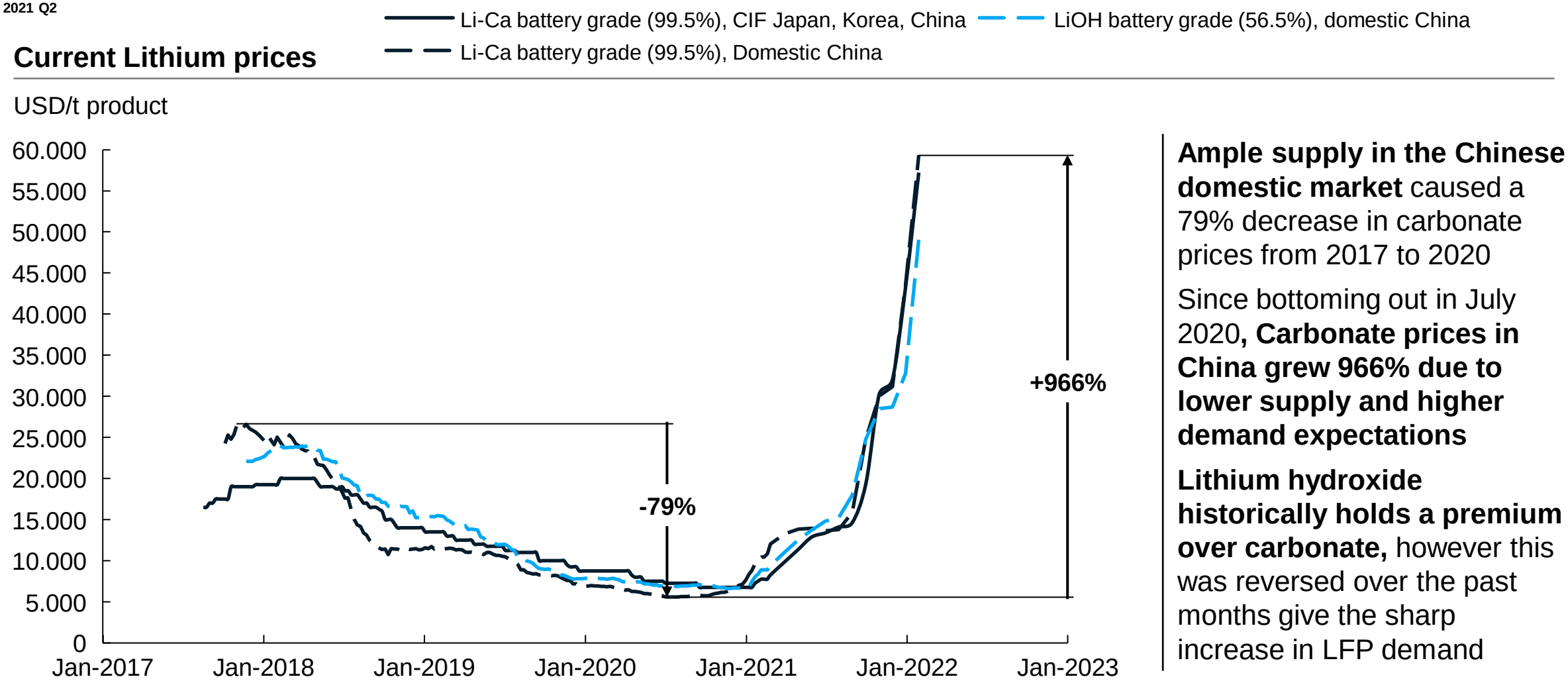
Fly up pricing could occur particularly in nickel and cobalt markets, leading to the reduction, and in cobalts case, potential elimination from the cell chemistry

OEM's must employ both optionality as well as aggressive sourcing to navigate both availablility as well as ESG requirements

After three years of declines, Lithium prices started a dynamic increase in 2021 as supply tightened– This likely will not last

2021 Q2

Current Lithium prices



Ample supply in the Chinese domestic market caused a 79% decrease in carbonate prices from 2017 to 2020

Since bottoming out in July 2020**, Carbonate prices in China grew 966% due to lower supply and higher demand expectations**

Lithium hydroxide historically holds a premium over carbonate, however this was reversed over the past months give the sharp increase in LFP demand

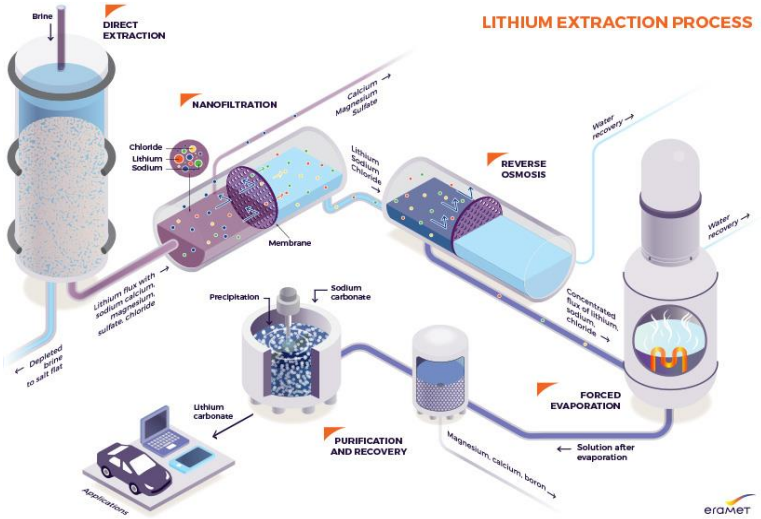
Source: Metal Bulletin

Direct Lithium Extraction is being developed as an alternative to conventional lithium brine production

Companies advancing the technology could unlock new resources

2021 Q2

Example process flowsheet from ERAMET



- Eliminates/reduces evaporation ponds footprint, also decreasing production time
- Higher expected recoveries from ~40% to 80-90%
- Lower usage of freshwater
- Expected increased product purity and lower reagent use for impurity removal (e.g. Mg, Ca, B)

Other companies advancing the technology

LAKE RESOURCES

- Partnering with Lilac Solutions to use DLE technology in the Kachi brine deposit in Argentina
- Currently under pilot trial and DFS fully funded
- Capacity of 25.5 ktpy LCE, targeted by 2024

Standard Lithium — POWERING THE FUTURE

- Partnering with Lanxess to produce lithium carbonate from oilfield brines in Arkansas, using spent brine from bromine production
- Currently under pilot trial, with tests for hydroxide conversion
- Capacity of ~21 ktpy LCE

VULCAN ENERGY RESOURCES — Zero Carbon Lithium®

- Piloting a DLE process for geothermal brines in Germany, using brine from electricity generation plants
- DFS expected by mid-2022
- Capacity of 35 ktpy LCE by 2024 being targeted

CHORI SIMCO LITHIUM

- Partnering with IBC Advanced Technologies to use Molecular Recognition Technology (MRT) in the Salar de Maricunga deposit in Chile
- First lithium hydroxide from the pilot plant expected in 2022
- Capacity of ~ 20 ktpy LCE in full-scale

Source: ERAMET website; Company websites and presentations