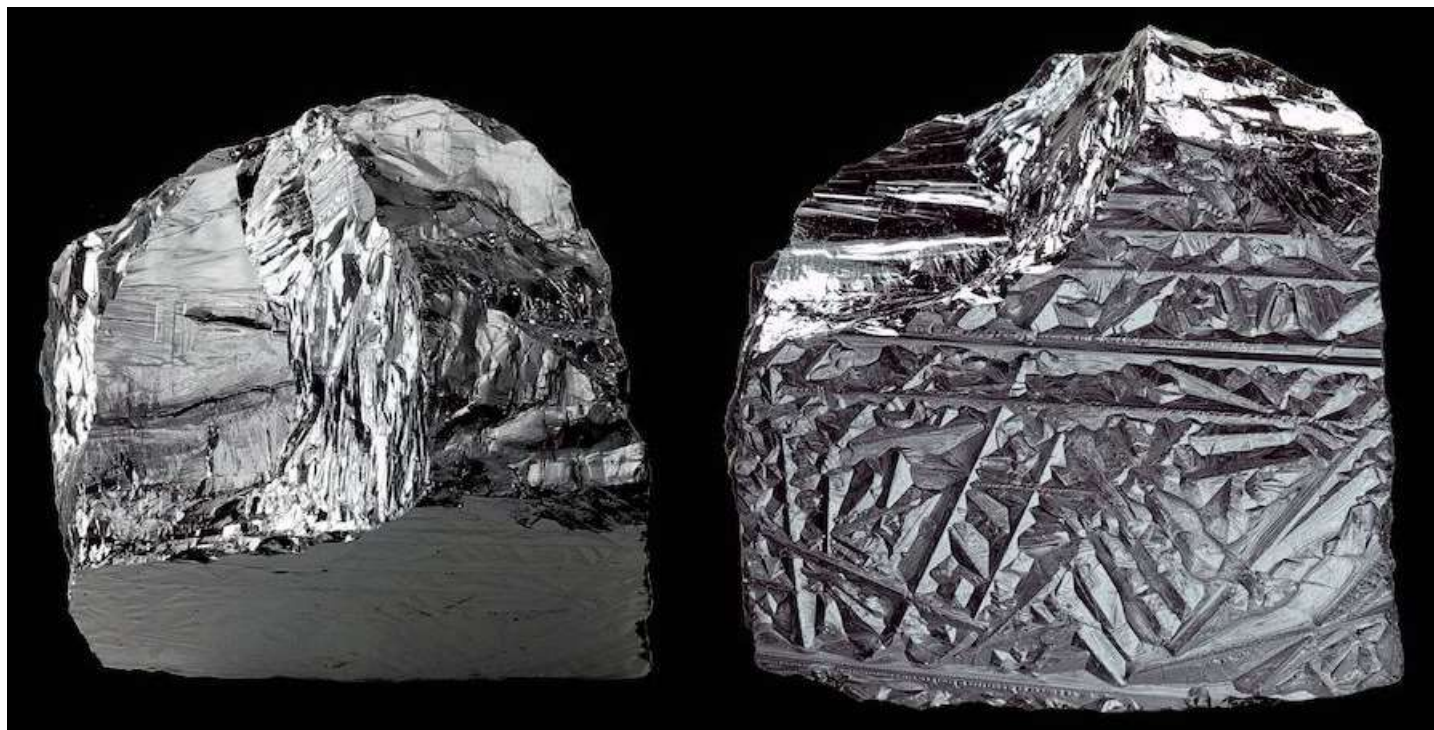


# White Gold: Lithium's Role in The Green Economy



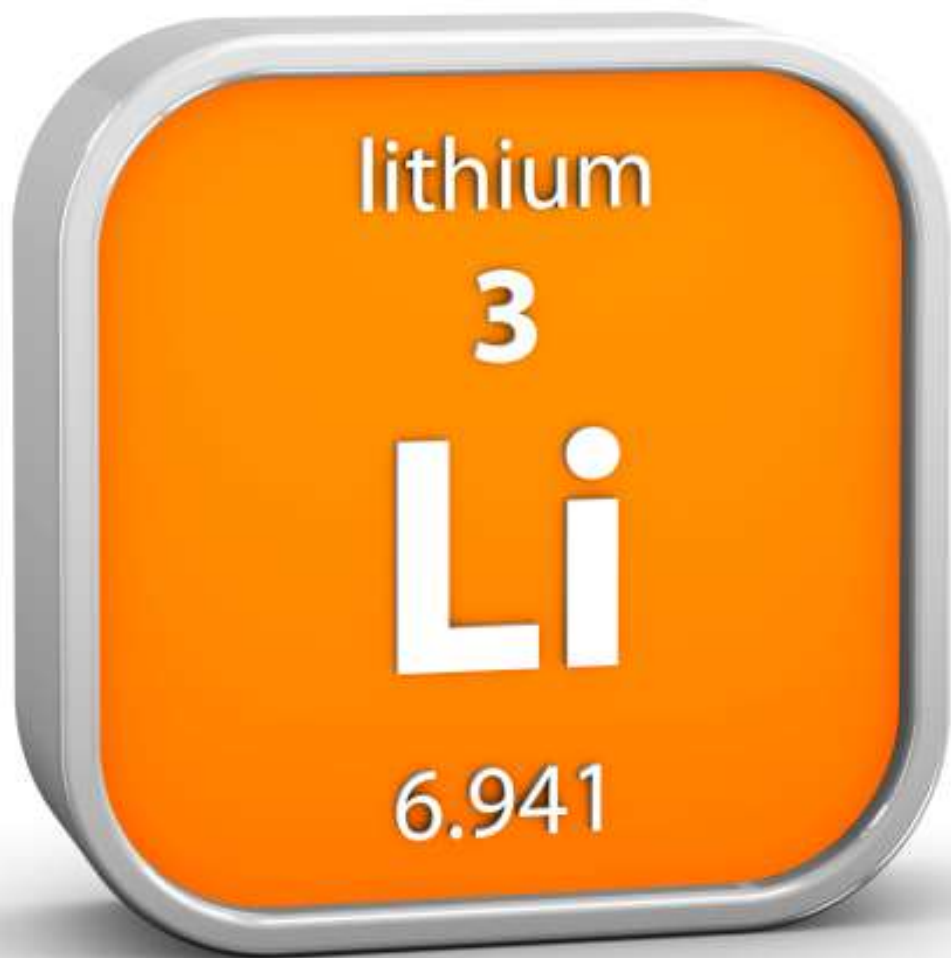
Wayne Palmer, EVP, Essential Minerals Association  
The Energy Council  
Federal Energy and Environmental Matters Conference  
June 24, 2023

lithium

3

Li

6.941



# Hardrock Spodumene



Source: King's Mountain Mining District, North Carolina, USA

# Lithium Brine

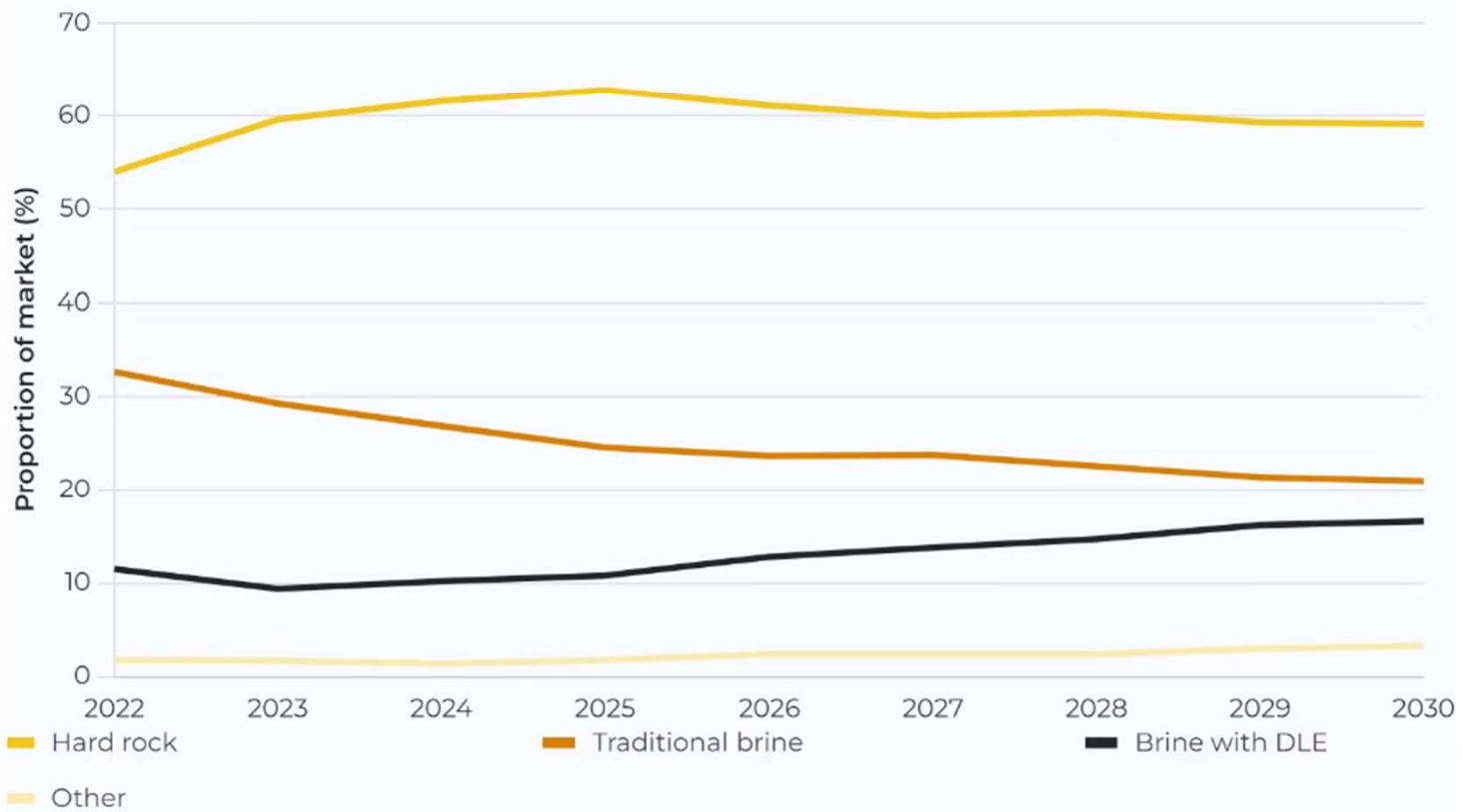


Source: Atacama Desert, Northern Chile



# DLE sources encroaching on traditional brine by end of decade

Proportion of mined lithium market share by lithium source type

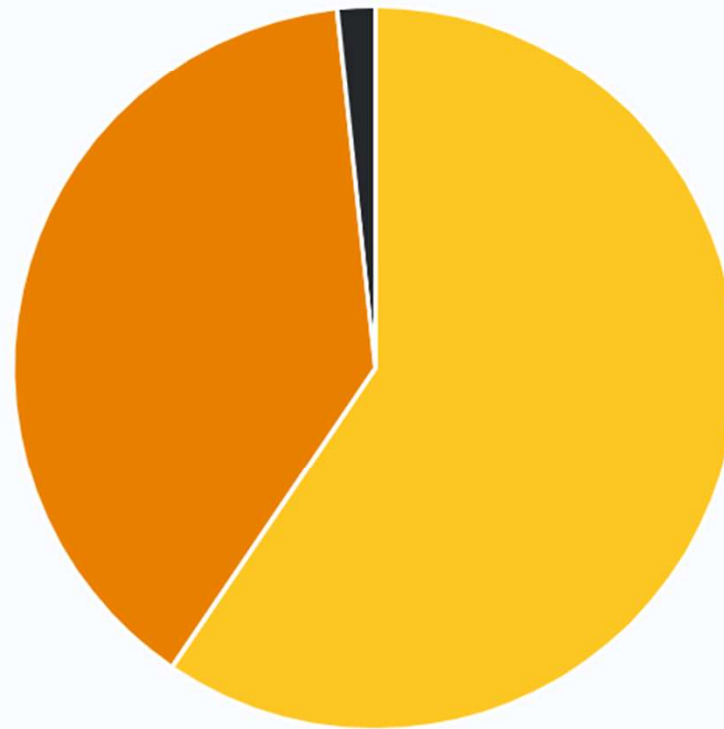


SOURCE: BENCHMARK LITHIUM FORECAST Q4 2022



## Hard rock sources of lithium make up 60% of mined lithium market

Share of 2023 mined lithium market by ore type



Hard rock

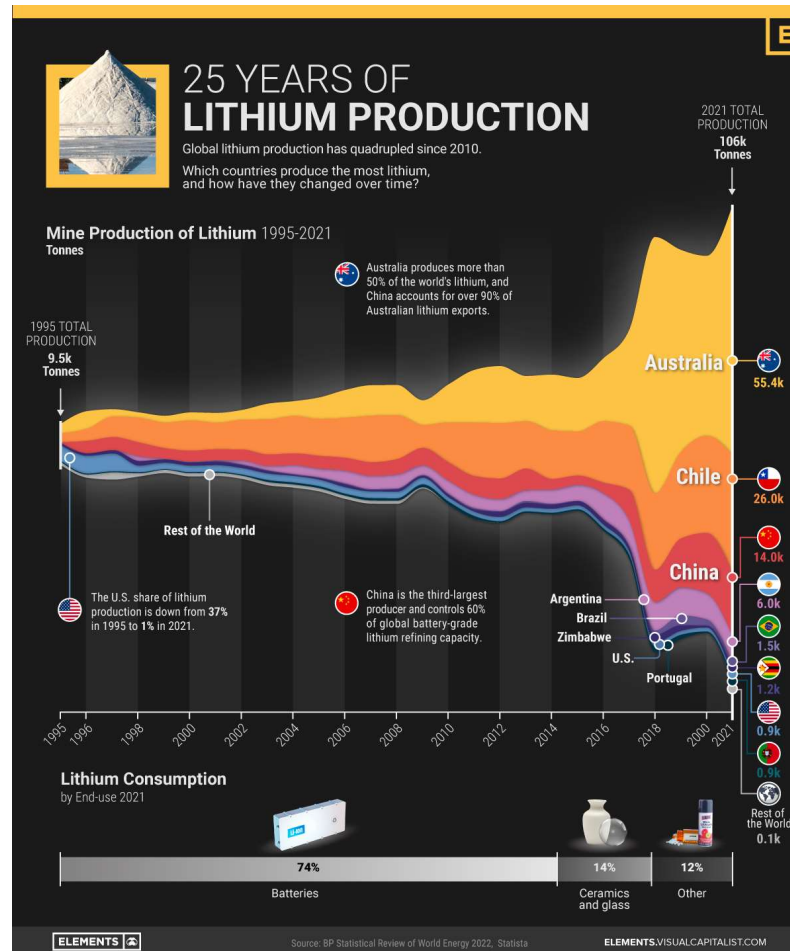
Brine

Other

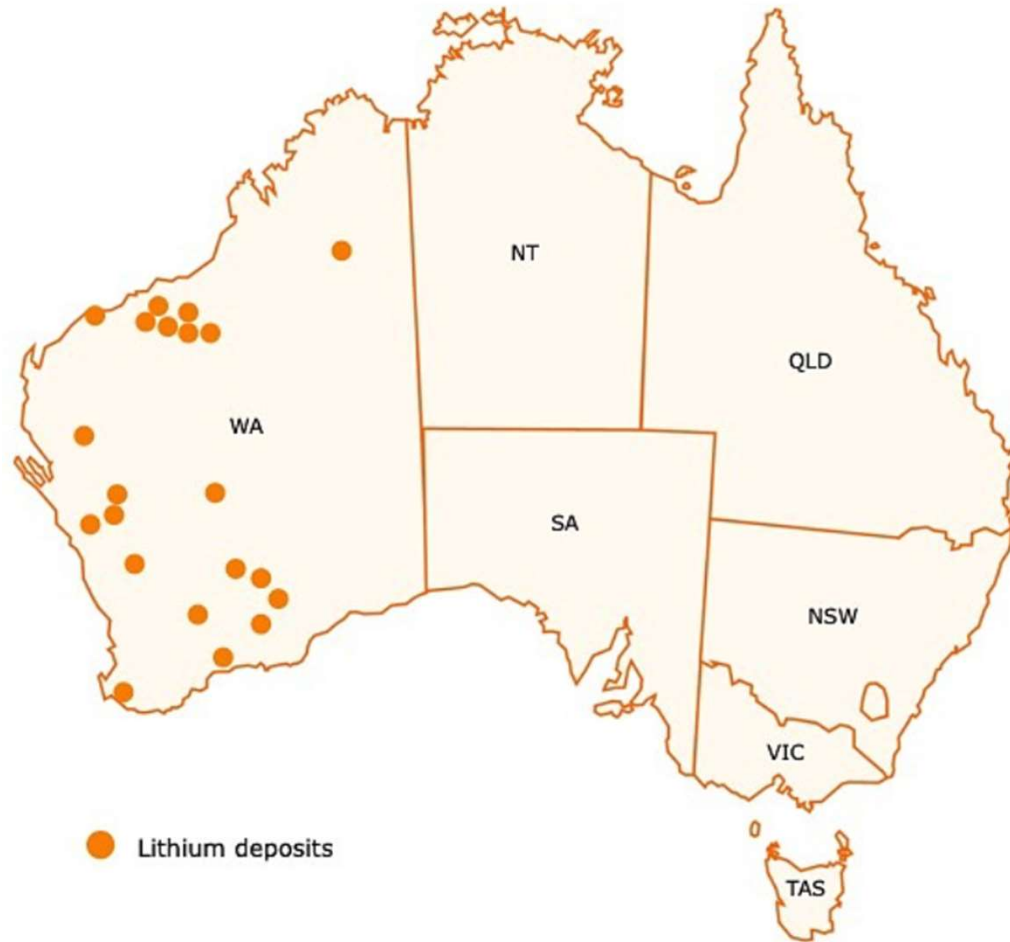
SOURCE: BENCHMARK LITHIUM FORECAST Q4 2022

 BENCHMARK

# Global Lithium Production



# Australia's Lithium Deposits



Source: SmallCaps.com



# South America's Lithium Triangle

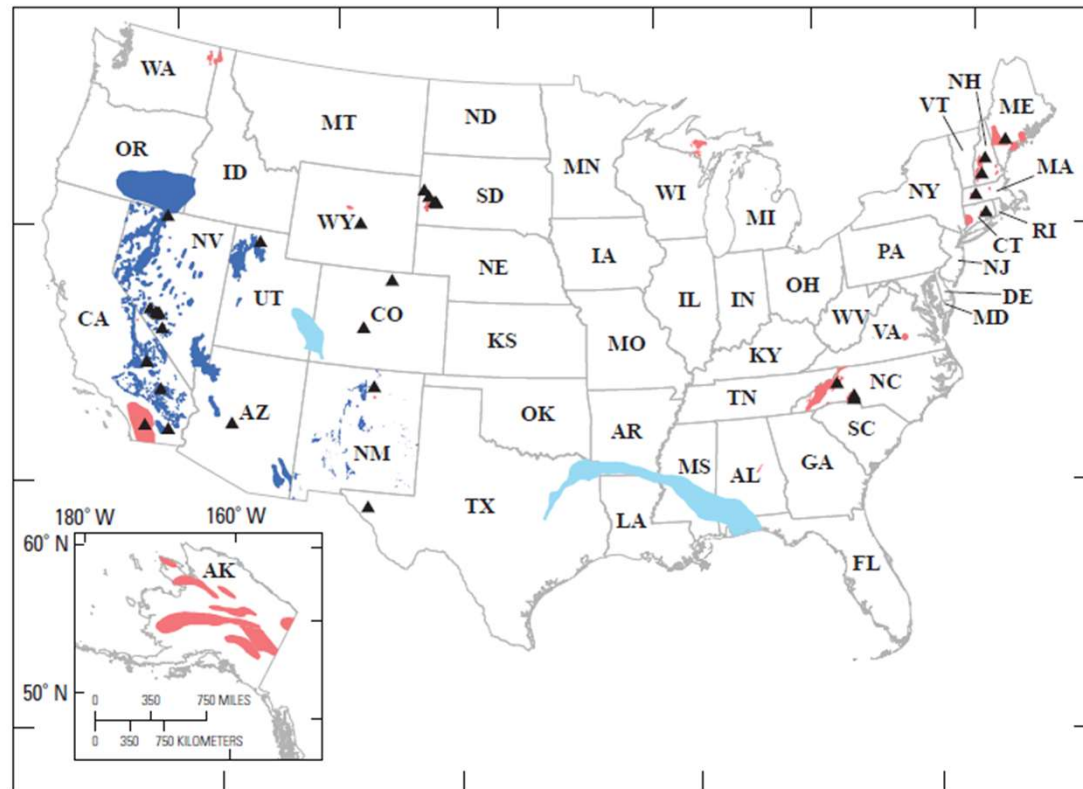


Source: Atlassons Business Services Private Limited

# China's Lithium Mines & Processing Plants



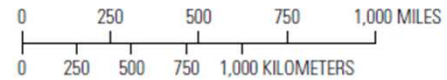
# Domestic Lithium Placement



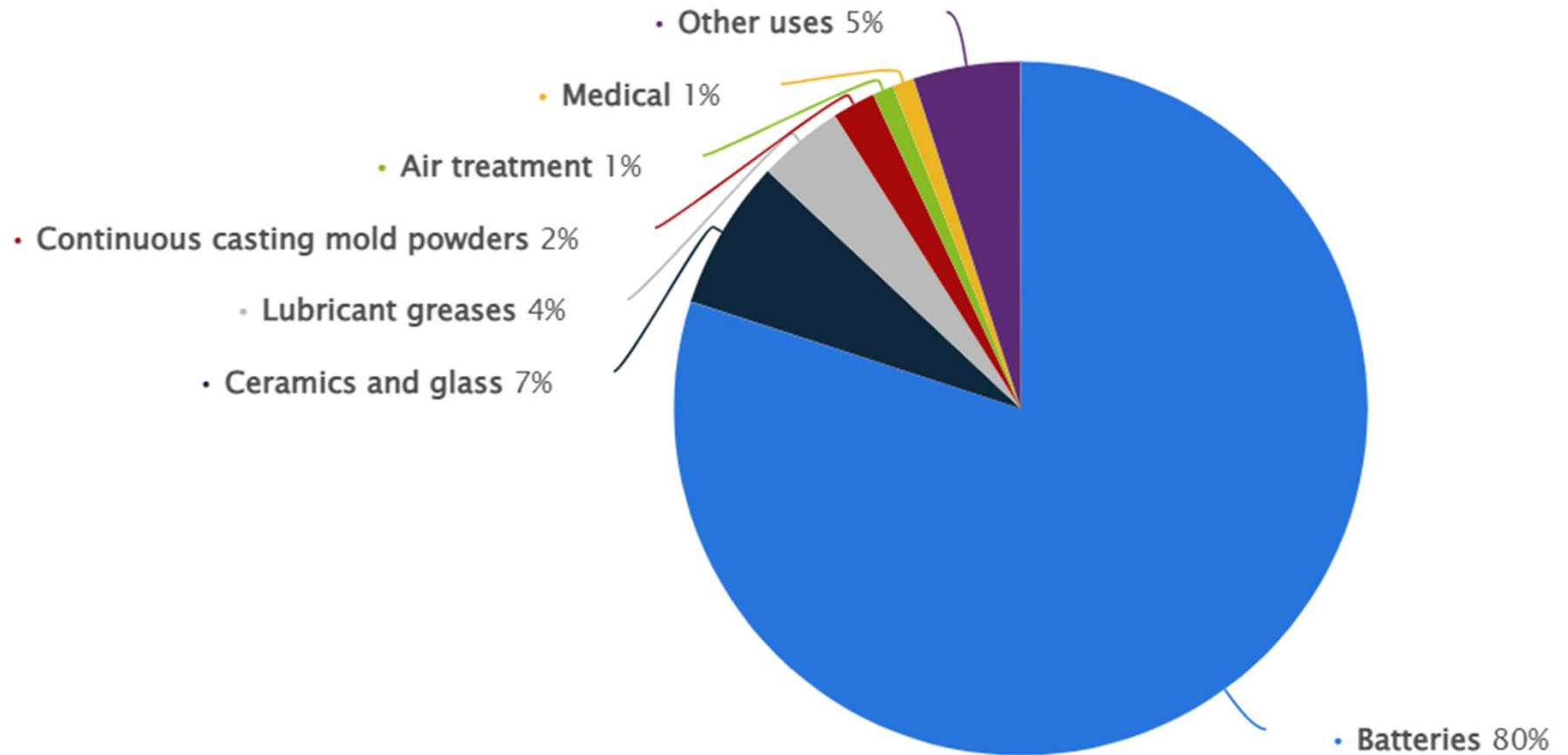
Source: United States Geological Survey & Association of American State Geologists

## EXPLANATION

- Mineral system**
- Basin brine path
  - Lacustrine evaporite
  - Porphyry Sn (granite-related)
  - ▲ Lithium deposits

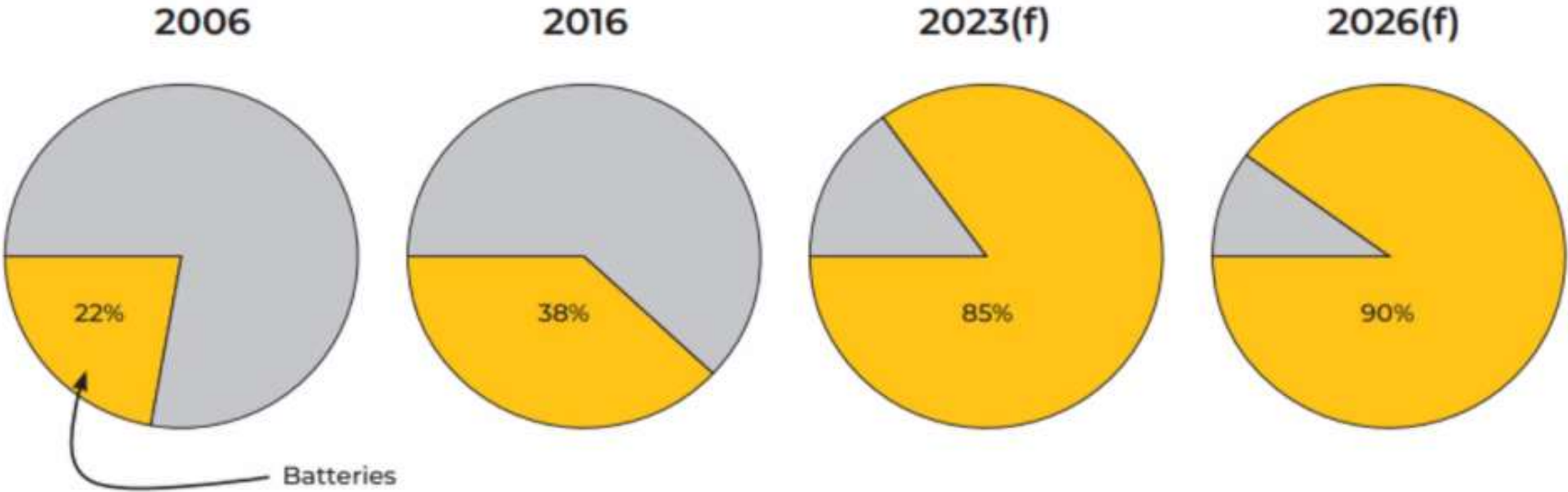


# Current Global End-Uses for Lithium



Source: Statista 2023

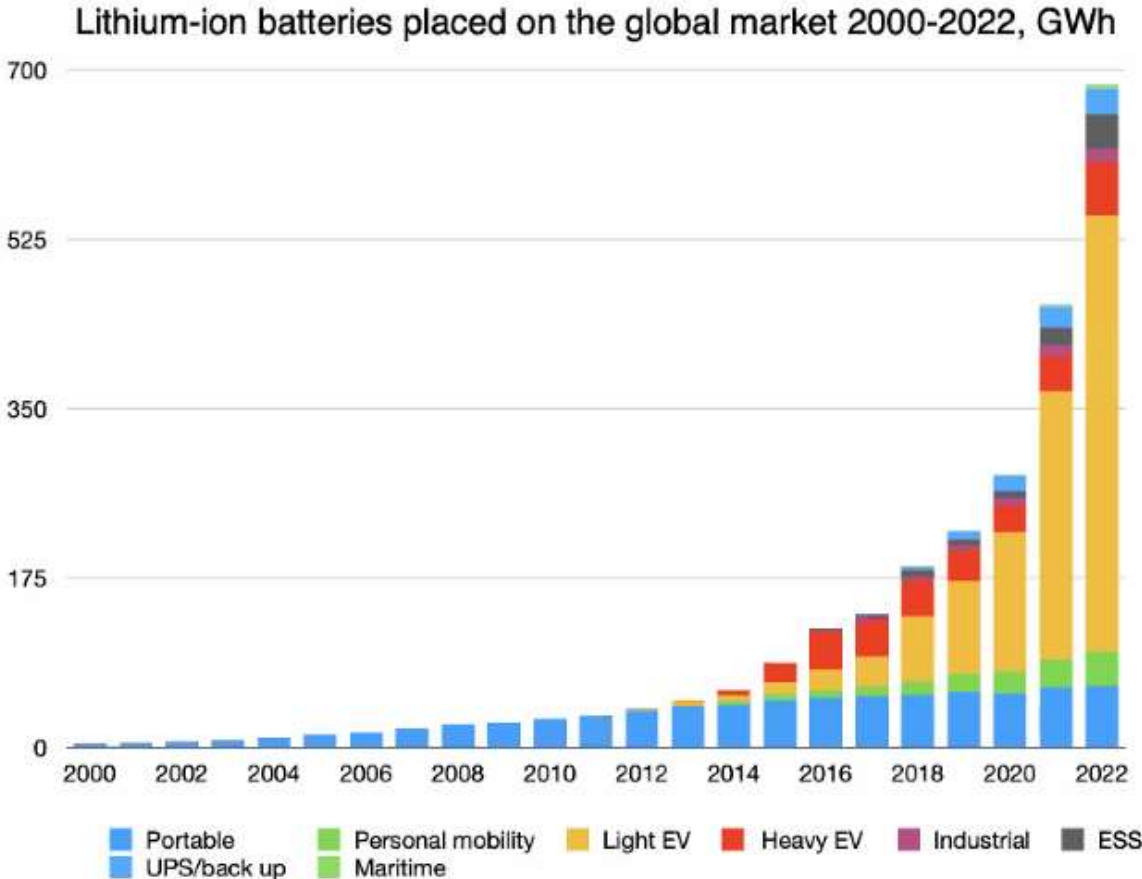
# Growth of Lithium Use in Batteries



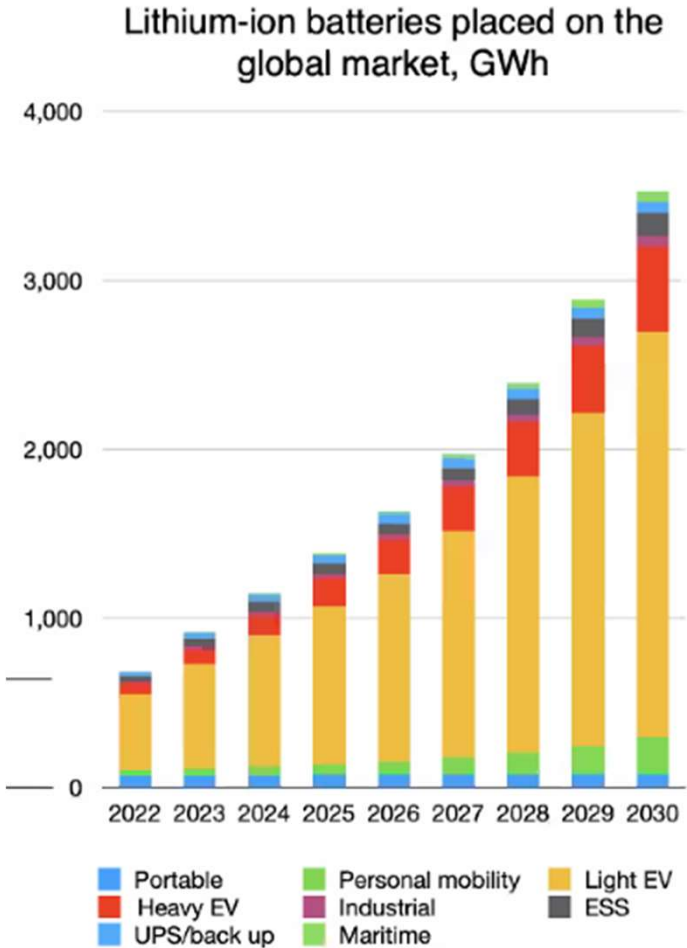
SOURCE: BENCHMARK MINERAL INTELLIGENCE



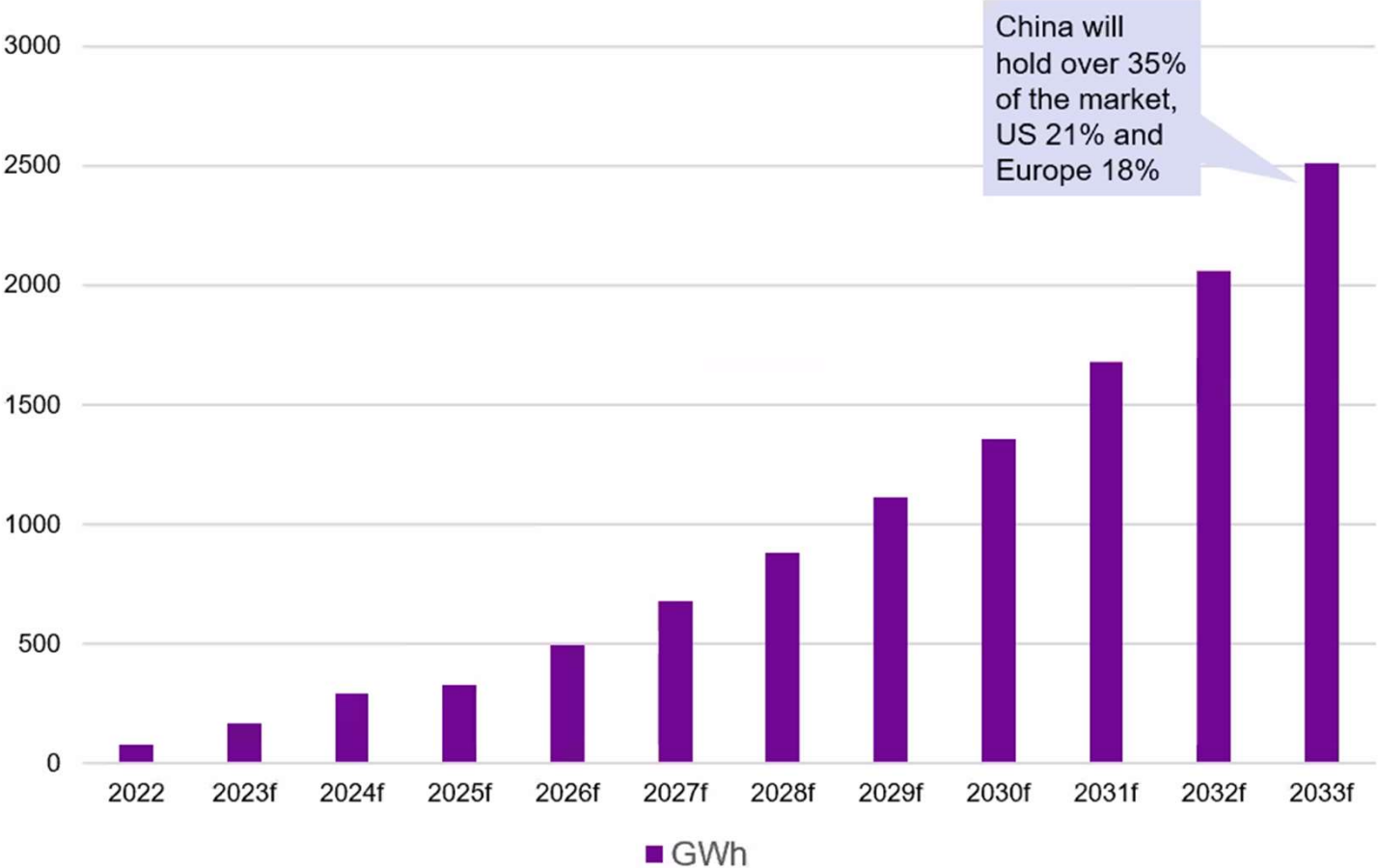
# Historical Uses for Lithium-Ion Batteries



# Projected Uses for Lithium-Ion Batteries



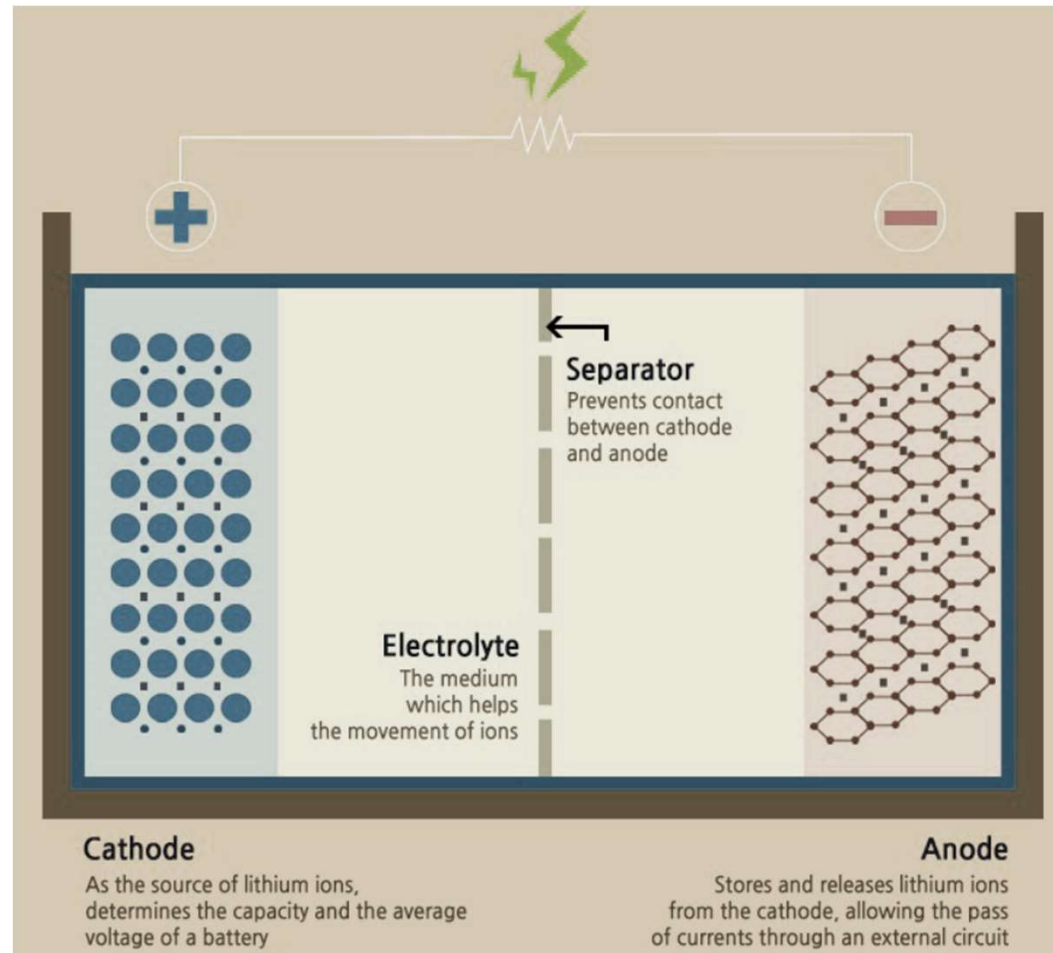
# Projected Growth of Stationary Energy Storage



Source: Fastmarkets BRM Long Term Forecasts



# Basic Battery Design

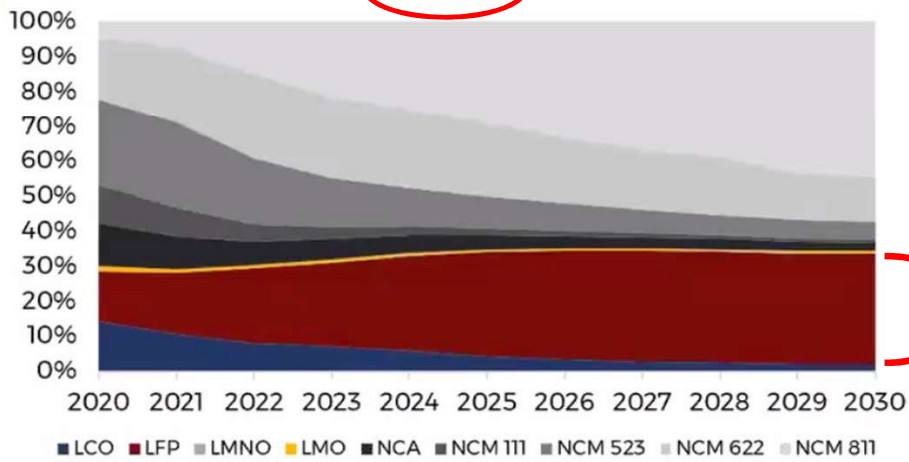


# Main Types of Lithium-Based Chemistries

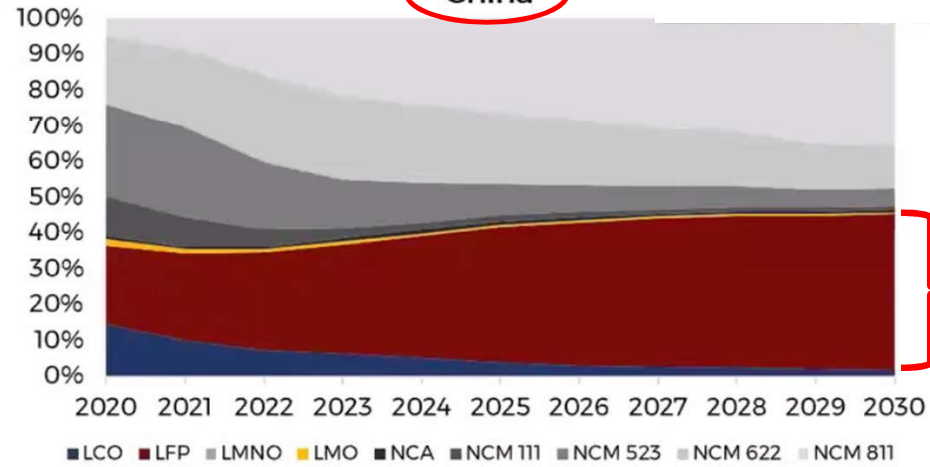
Type	Primary Uses
Lithium Nickel Manganese Cobalt (NMC)	EVs, E-bikes, E-rikshaws, industrial equipment, medical equipment, power tools
Lithium Nickel Manganese Cobalt Aluminum (NMCA)	EVs, medical devices, industrial equipment
Lithium Cobalt Oxide (LCO)	EVs, smart watches, mobile phones, tablets, laptops, cameras
Lithium Ion Manganese Oxide (LMO)	EVs, power tools, medical equipment
Lithium Nickel Cobalt (NCA)	EVs, grid energy storage
Lithium Titanate (LTO)	EVs, e-bikes, uninterruptable power supply (UPS) backup power for connected equipment
Lithium Iron Phosphate (LFP)	EVs, heavy machinery, E-bikes, E-rikshaws, grid energy storage, replacing lead-acid deep-cycle batteries (cellphones, boats, RVs, scooters, solar)

# Cell Production by cathode chemistry (%)

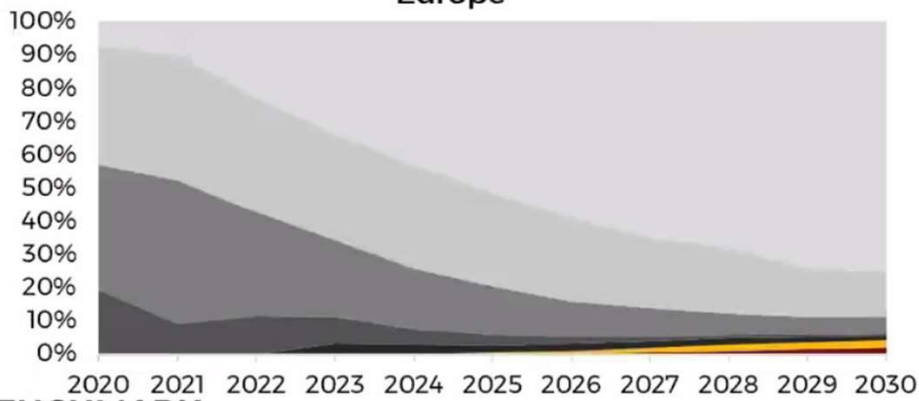
Global



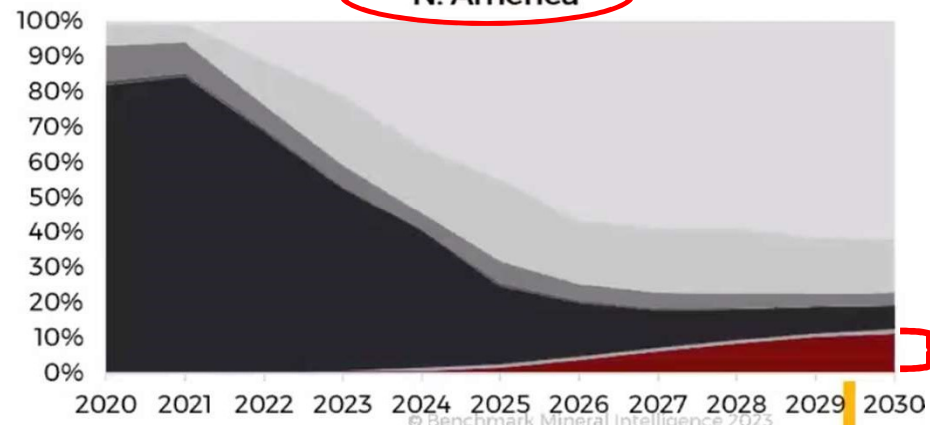
China



Europe



N. America



# NCM and LFP Batteries

Both offer advantages based on customer needs



## Pros:

- Higher Energy Density
- Lighter, So Longer Range
- Better for Towing & Hauling

## Cons:

- Prone to Ignition
- Nickel and Cobalt Costly & Problematic for ESG

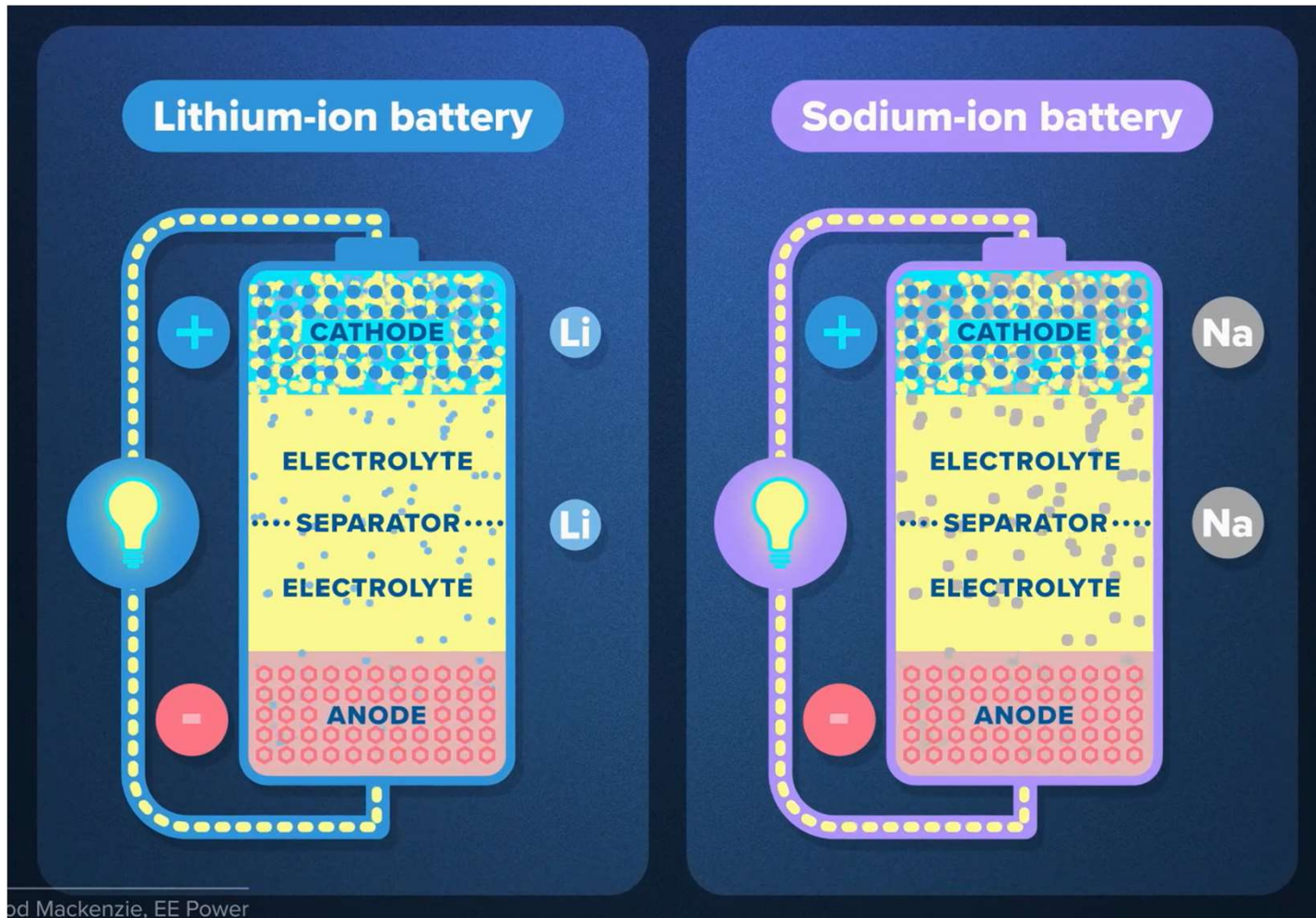


## Pros:

- Less Expensive
- Do Not Require Cobalt & Nickel
- Not Prone to Ignition
- Charge up to 100%

## Cons:

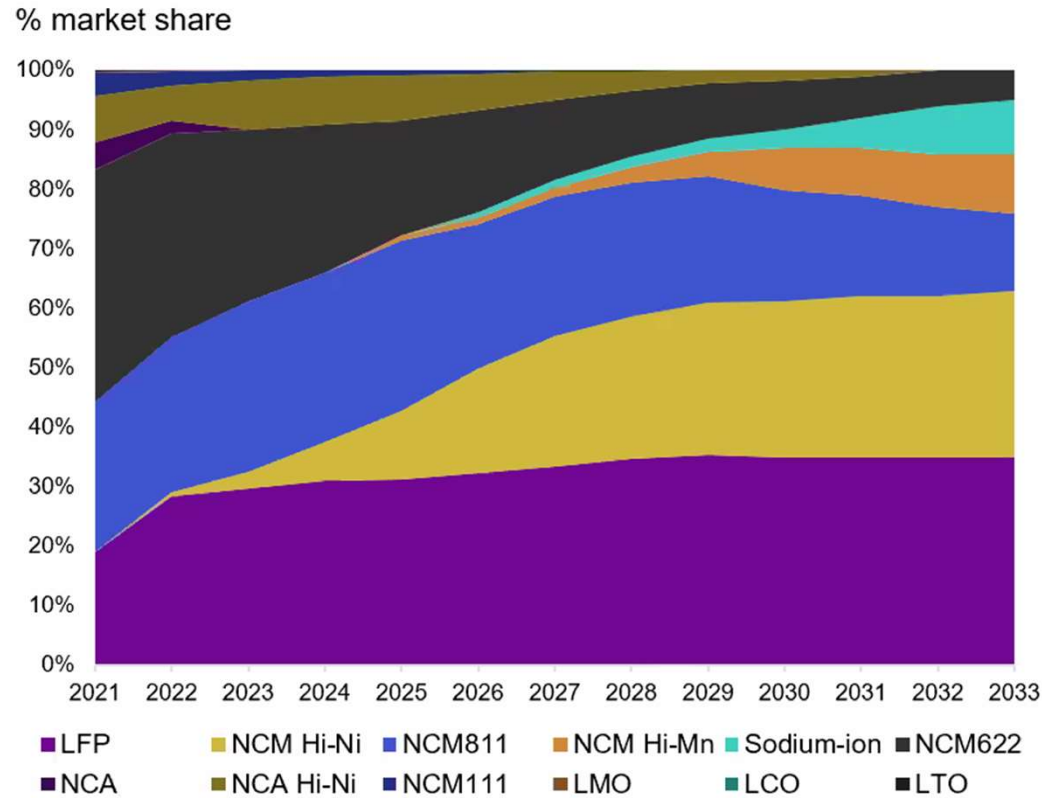
- Heavier, So Less Range



Wood Mackenzie, EE Power

Source: Wood Mackenzie; EE Power

# Passenger Electric Vehicle Chemistry Forecast



- 2033 expectations: LFP holds 35% of PEV market share, NCM 56% and sodium-ion 9%

Source: Fastmarkets BRM Long Term Forecasts

# Growth Projection for Solid State Batteries

