1. Introduction to Base Metals

Definition and Overview

<u>Definition:</u> Base metals are **industrial non-ferrous** metals **excluding precious metals.**

Such as copper, zinc, nickel, aluminum, and lithium.

Lithium isn't traditionally a base metal but is often grouped as such due to the **similar economic properties**.

2 main types of lithium:

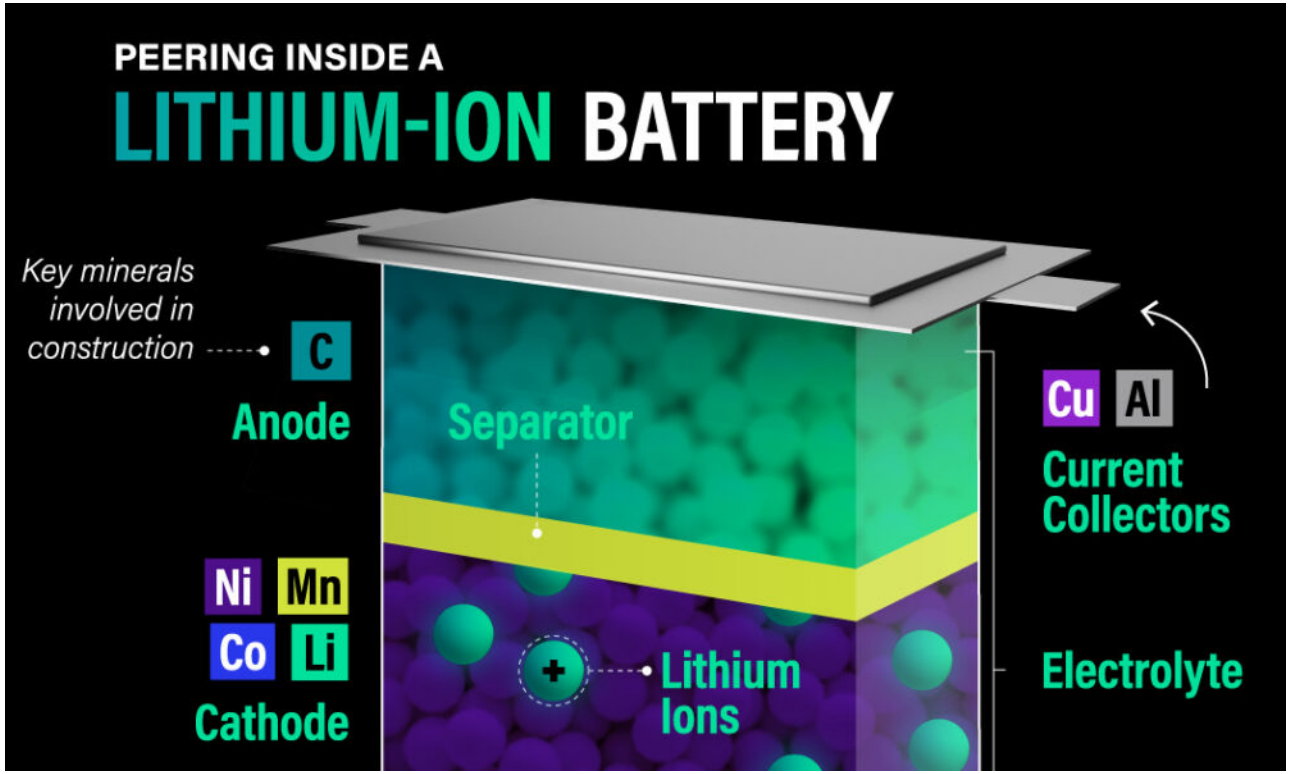
- Lithium Hydroxide
- Lithium Carbonate

Importance in Industry

Lithium plays a crucial role in the **Electronic Vehicle (EV)** sector.

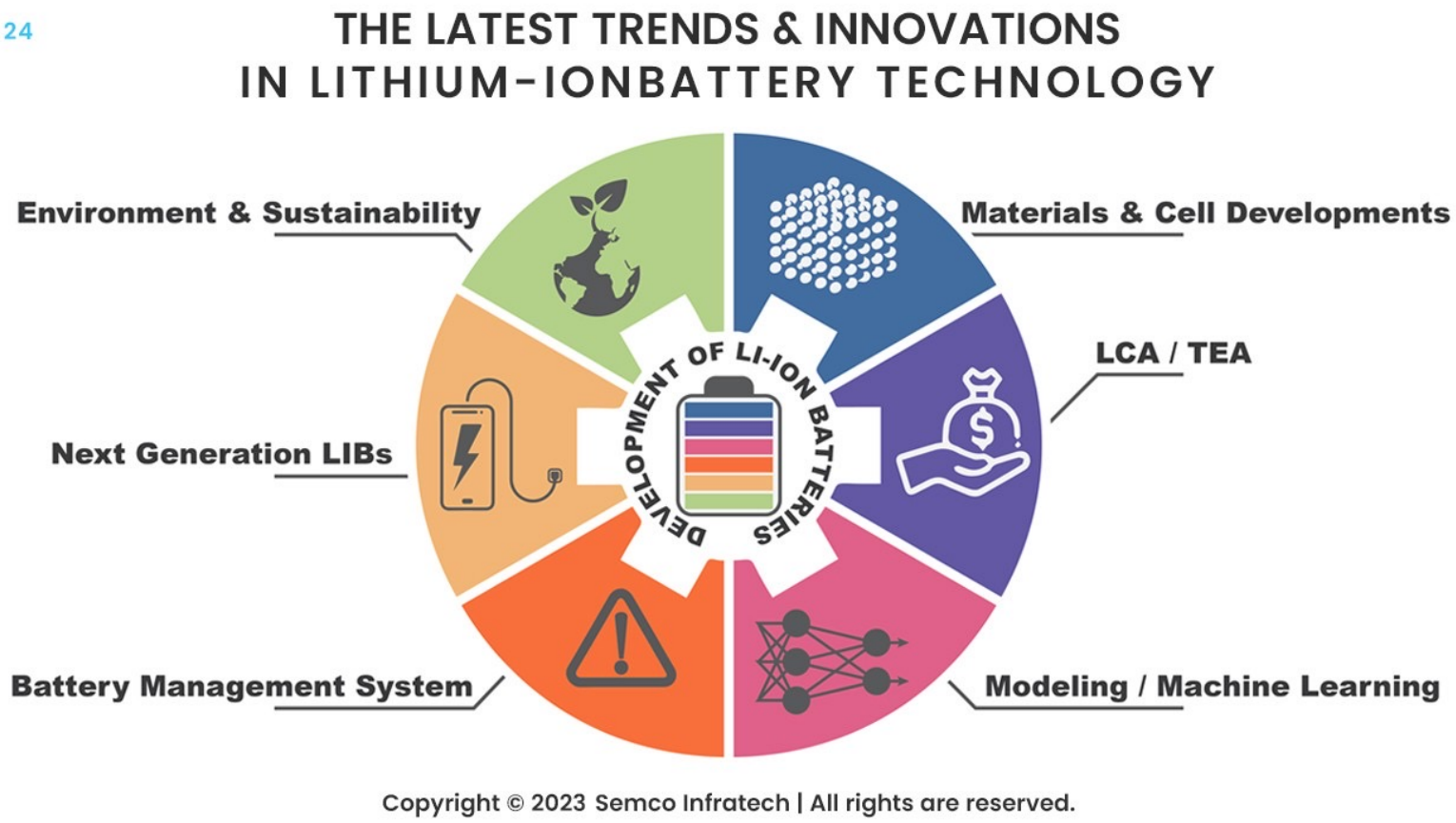
Energy dense, **lightweight**, and **rechargeable** lithium-ion batteries.

Lithium hydroxide is preferred for these batteries due to **improved stability** and **energy density**.



Importance in Industry

Due to the role it plays in renewable energy storage, it is pivotal in achieving net zero carbon emissions.



Historical Context

Discovered in **1817** by Johan August Arfwedson

Used in **medicine**, **glass** and **ceramic manufacturing**, **greases** and **lubricants**, and **tires before** their use in **lithium-ion batteries.**

First surge in usage came with the **introduction of portable electronics** in the late 1900s. This growth continued **exponentially** with the **adoption of EVs** and a shift to more **sustainable** energies.

2. Market Overview

Major Markets & Exchanges

Major Markets:

- China
- The US
- Australia
- Chile
- South Korea
- Japan
- Europe

Major Exchanges:

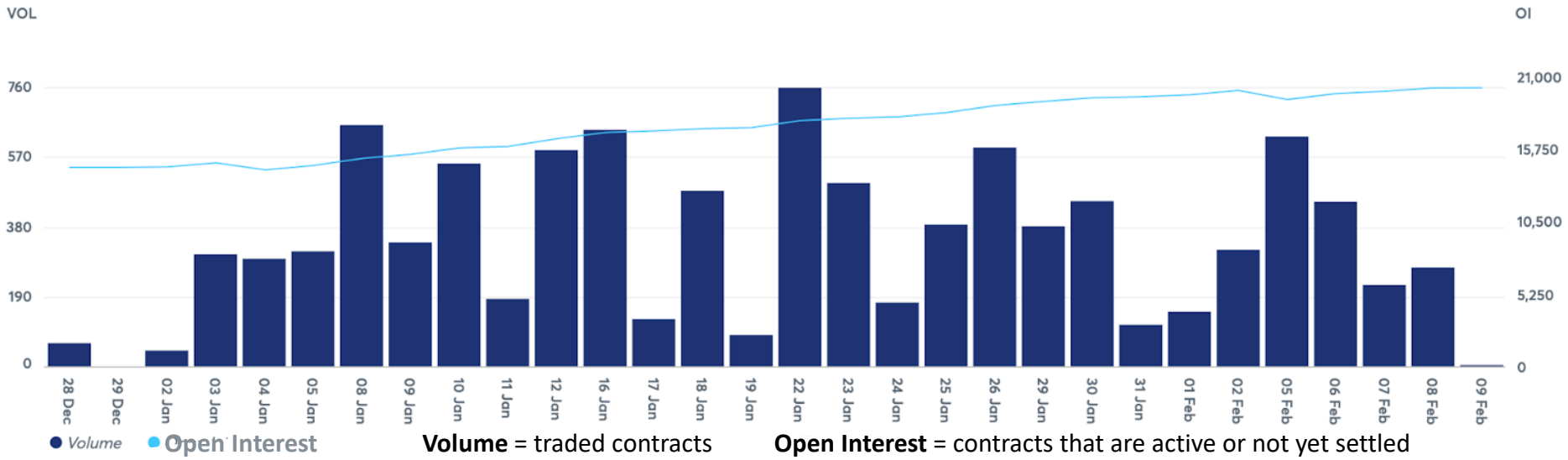
- London Metal Exchange (LME)
- Chicago Mercantile Exchange (CME)

CME Group

LME
An HKEX Company

LITHIUM HYDROXIDE CIF CJK (FASTMARKETS) FUTURES - VOLUME & OPEN INTEREST

View Metals Asset Class Volume and Open Interest



Volume = traded contracts **Open Interest** = contracts that are active or not yet settled

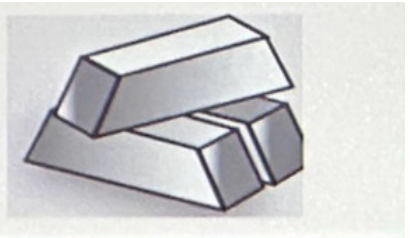
Major Markets & Exchanges

The **average daily trading** volume of CME **lithium hydroxide futures** contracts (each contract represents **one metric ton**):

- 174 contracts per day (November 2023)
- 195 contracts per day (December 2023)
- 358 contracts per day (January 2024)

***Less than 1% of the open interest contracts are traded every day.**

*Due to the **old school** and **relationship-based structure** of **metal trading**, most trades are made **in-person without any futures** or **forward contracts**



Metals Trading

- Old school & relationship based
- Least quantitative
- Dominated by commodity traders and full value-chain mining giants
- Strong focus on physical business
- Big Players:
  - Glencore
  - Trafigura
  - Vale
  - Nyrstar
  - Big Mining Companies
- Backgrounds: all backgrounds (some mining engineers)
- Pathway to trading: 5-10 years usually

Key Players

Major Markets:

- China

-Largest consumer and 3rd in production in the world 2022

- The US

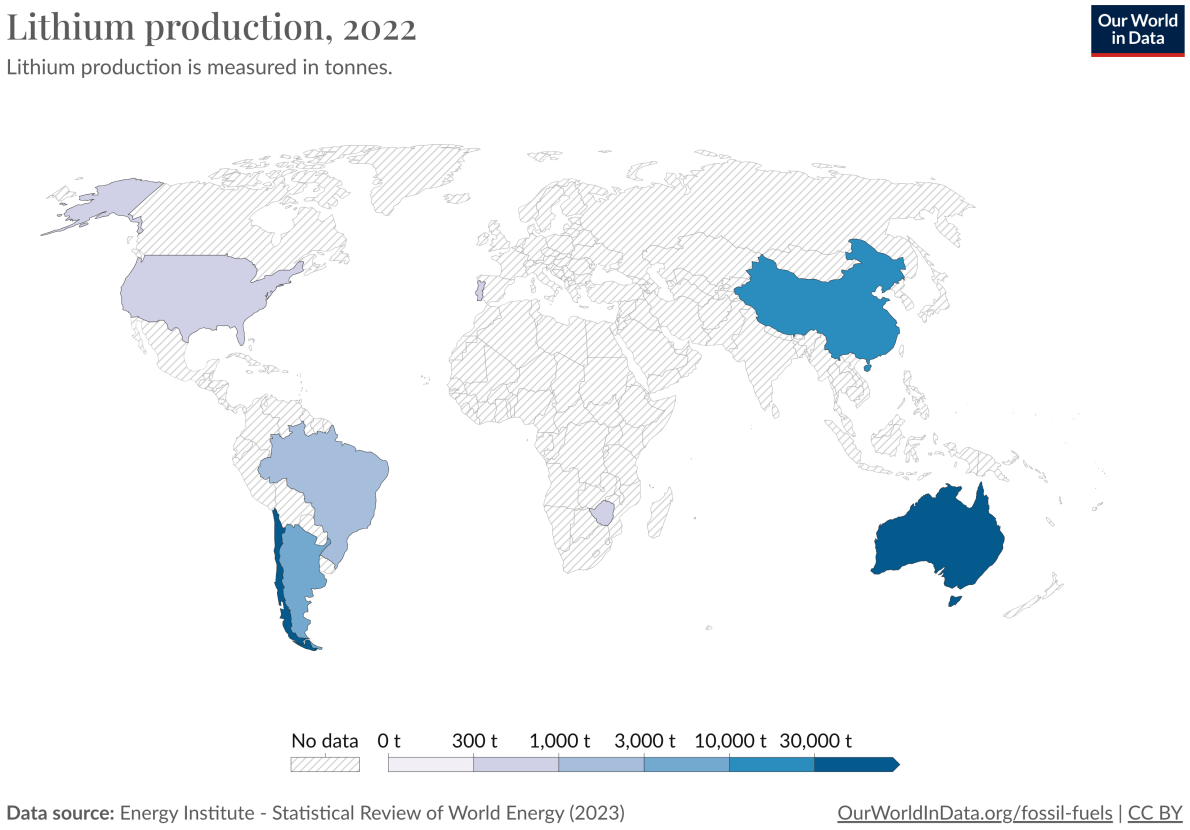
-Big consumer, also home to several mining
& processing operations

- Australia

-Leading producer (53%) July 2023

- Chile

-Home to some of the world's largest lithium reserves



***Australia exports 96% of the lithium it produces to China** 2023

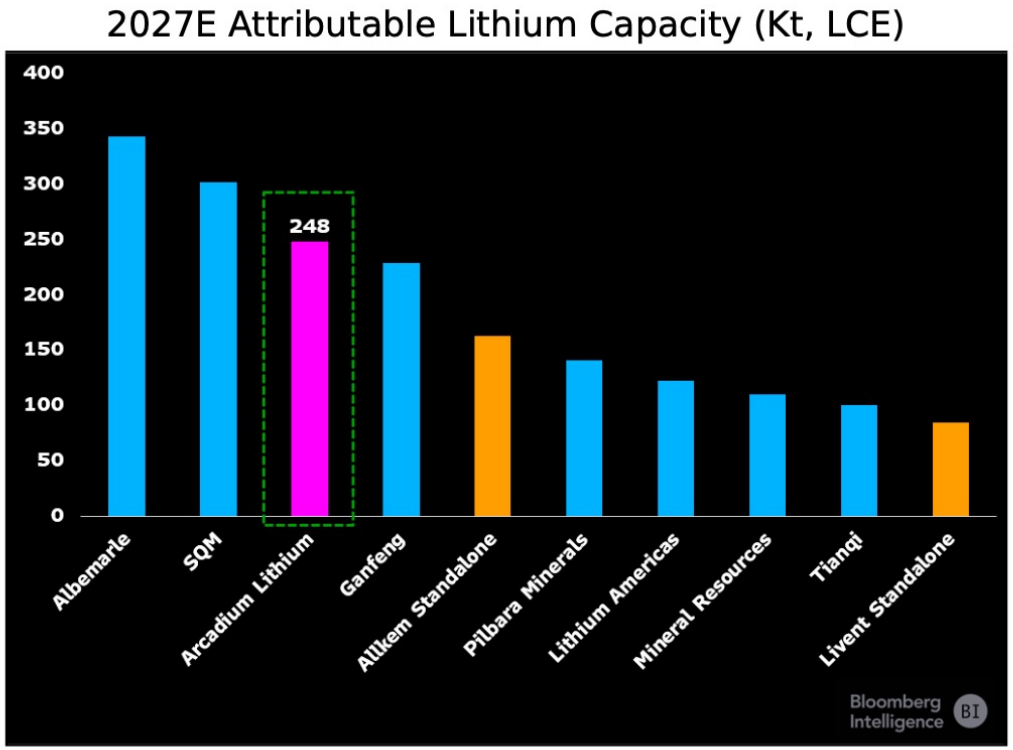
Key Players

Major Mining Companies:

- Albemarle Corporation
- Sociedad Química y Minera de Chile (SQM)
- Tianqi Lithium
- Ganfeng Lithium
- Pilbara Minerals
- Atlantic Lithium
- Lithium Americas
- Alkem
- Minreal Rescources Ltd

Major lithium-ion battery producers:

- CATL
- BYD
- LG Chem
- Panasonic
- Tesla
- Samsung SDI
- EVE Energy
- Lishen Battery
- DNK Power



Source: Company Filings, Bloomberg Intelligence

Key Players

- The production of lithium is controlled by 5 big companies. (Albemarle, SQM, Arcadium Lithium, Ganfeng, Tianqi.)
- Together, they make up about 50% to 60% of the total production.

Regulatory Landscape

Mining Regulations:

Environmental Assesments

Minimizing harm to ecosystems, water quality, air quality, and ecosystems

Water Management

Protects surface water and groundwater sources from the water pollution caused by lithium mining

Land Use Planning

Finds suitable areas for the mining operations with respect to economic development, environmental impact, indigineous land rights, and etc.

Permitting Processes

Makes sure companies follow the other regulations

Economic Regulations:

Royalties & Taxes

Makes money for the government used towards public goods

Investment Incentives

Used to attract investment in the lihtium sector. Grants and tax credits

Export Controls

Aimed to manage domestic supply & support local industries

Market Regulations

Promotes fair competition, prevents anti-competitive prices

Trade Agreements

Promotes economic cooperation and integration between countries.

Shipping Regulations:

RID — European legislation regulating the transport of dangerous goods by rail

ADR — European agreement regulating the transport of dangerous goods by road

ADN — International agreement for the transport of dangerous goods by inland waterways

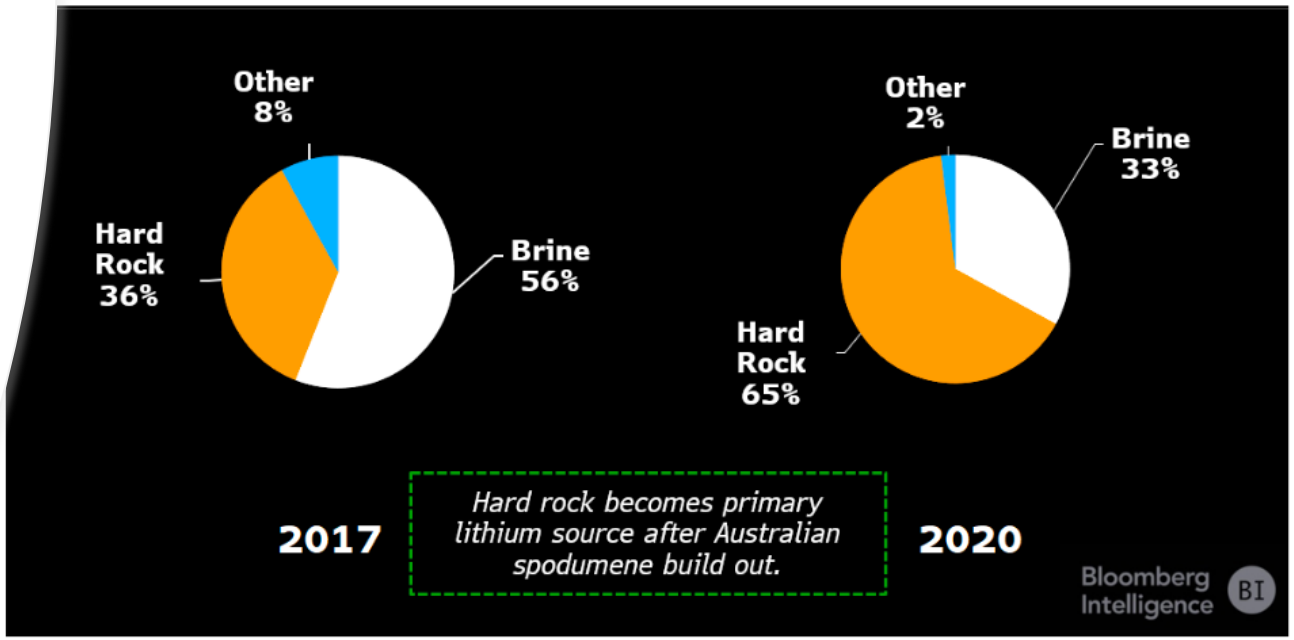
IMDG — International regulations for the maritime transport of dangerous goods

DGR — International air transport association dangerous goods regulations

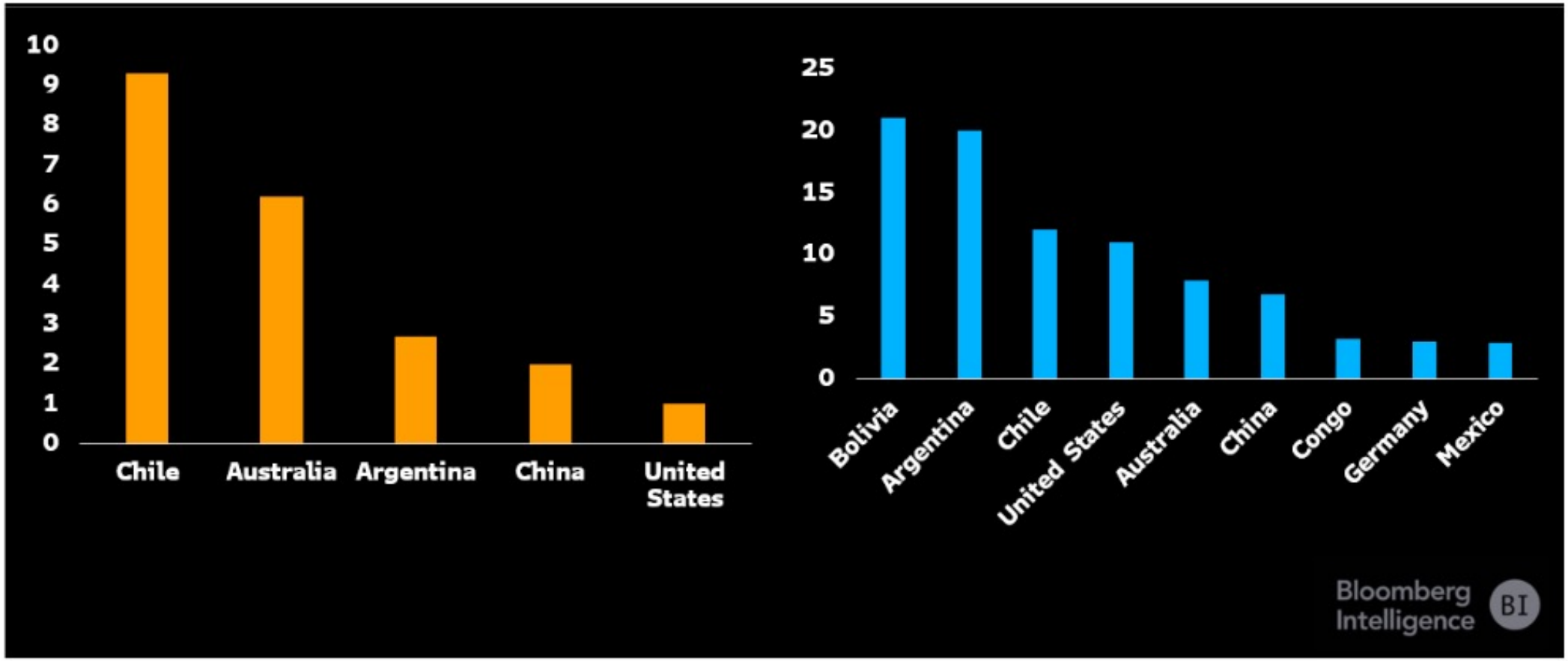
3. Fundamental Analysis

Supply Factors - Extractions

- Brine extraction offers lower upfront costs but requires substantial water evaporation in arid regions, raising environmental concerns.
- Hard rock mining, while more expensive, involves crushing and processing rock, often with higher energy consumption.

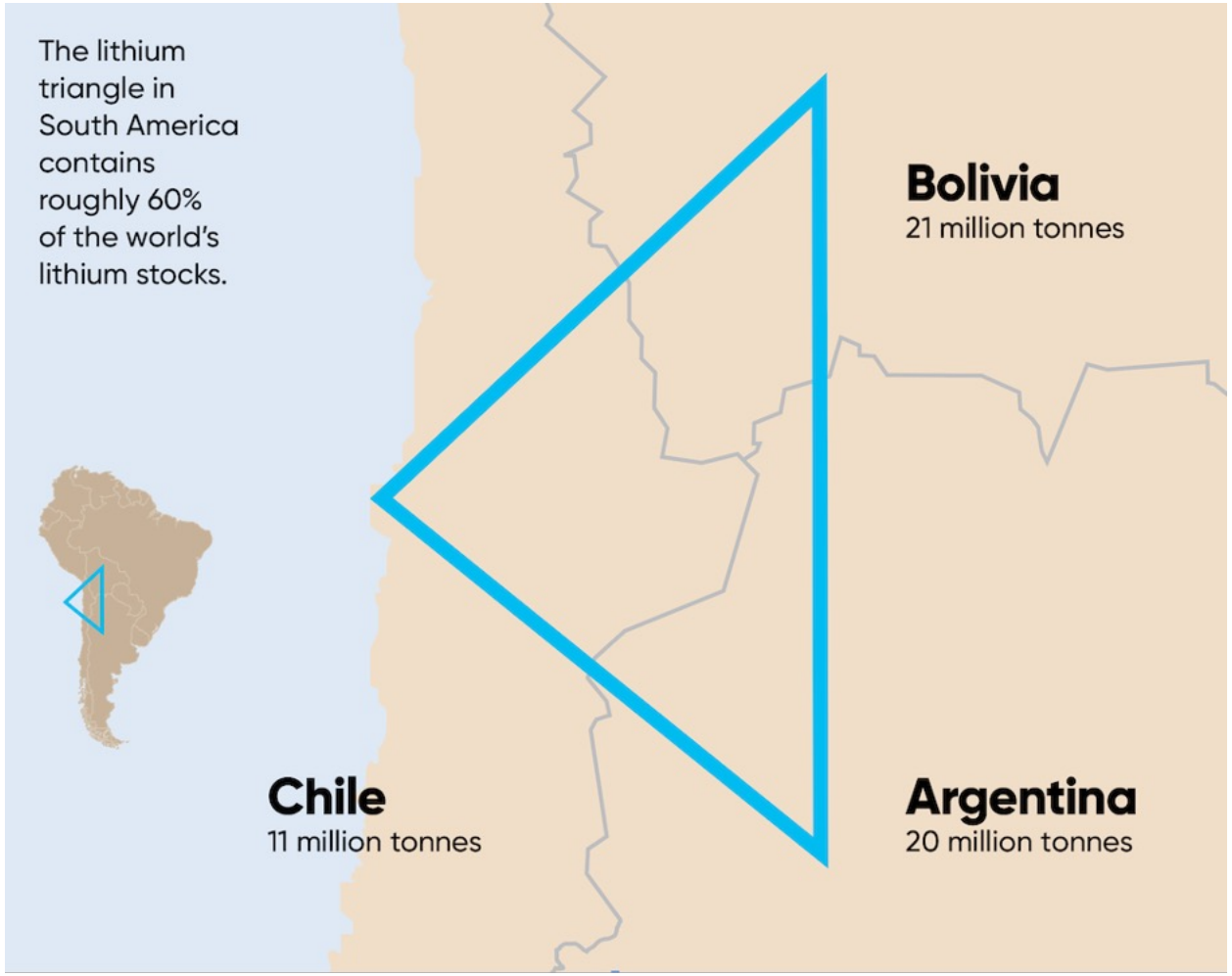


USGS: Reserves (LHS) & Resources (RHS), Mt

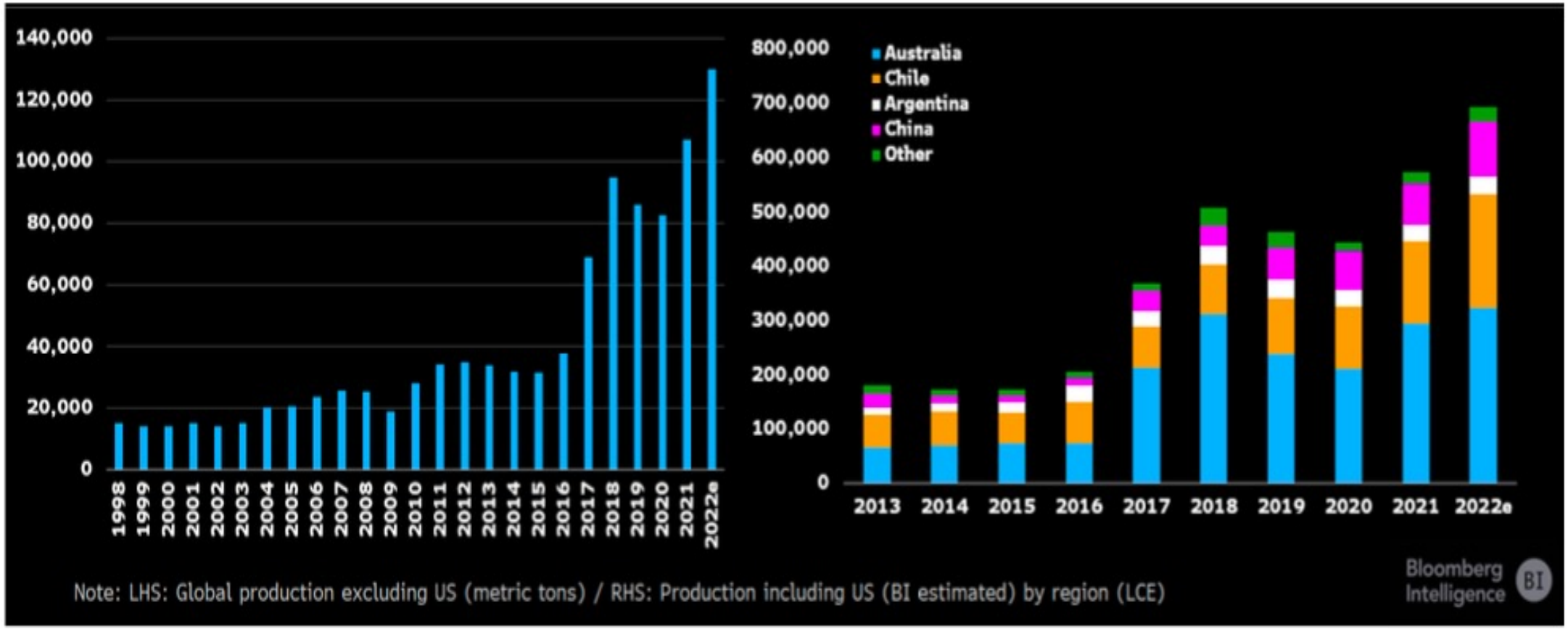


Source: USGS, Bloomberg Intelligence

Supply Factors – Lithium Triangle



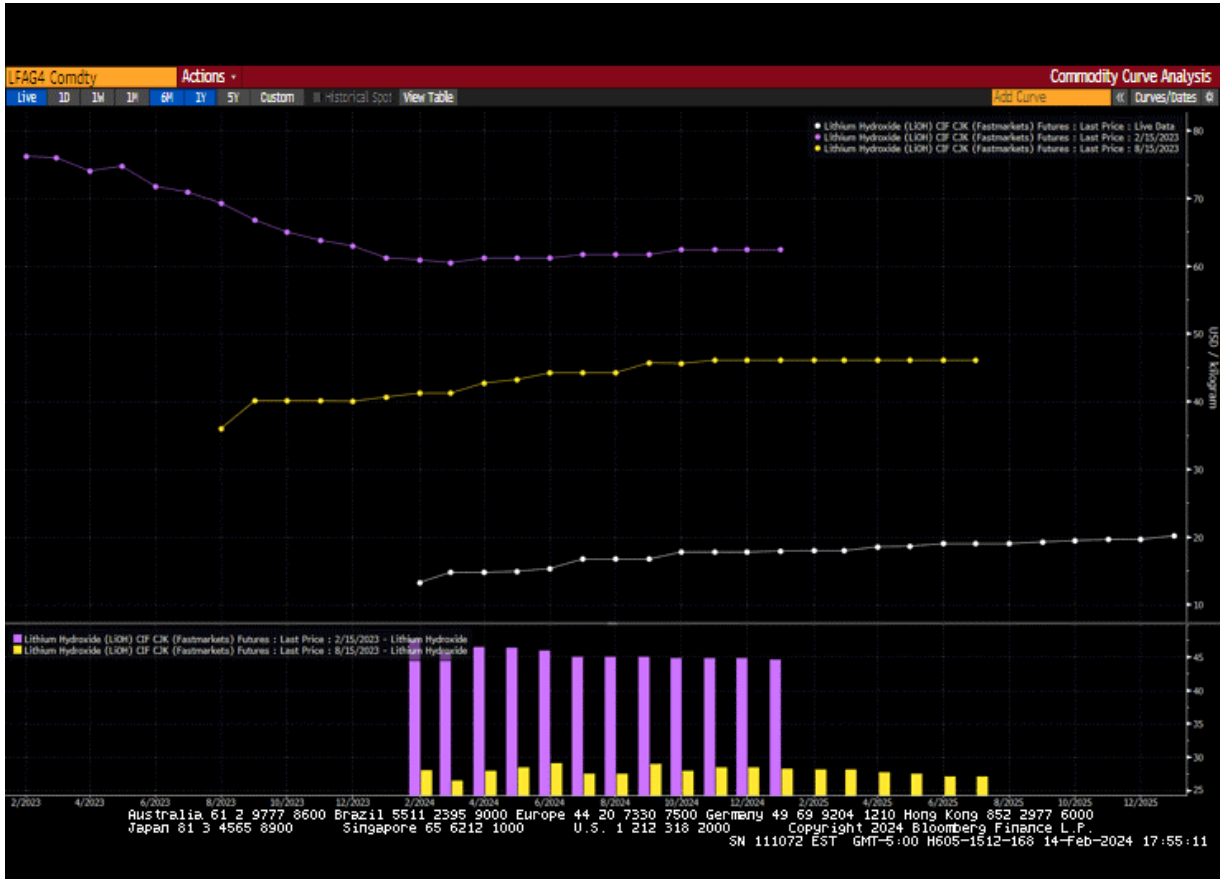
USGS Global Lithium Mine Production Data



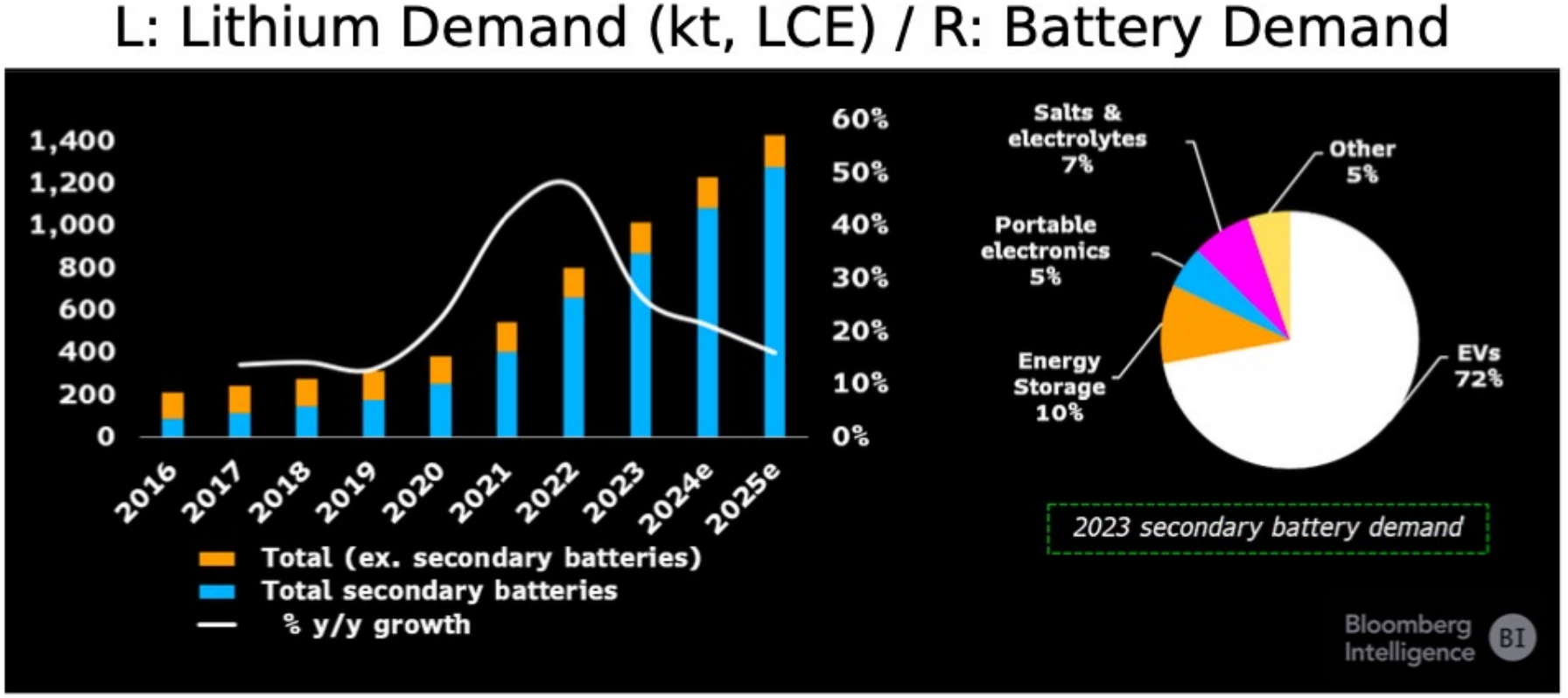
Source: USGS, Bloomberg Intelligence

Supply Factors - Costs

- The cost of lithium varies depending on the extraction method, location, and refining processes.
- As of 2023, the average cost of lithium carbonate from brine ranges from $5,000 to $7,000 per tonne, while hard rock lithium carbonate falls between $7,000 and $9,000 per tonne.
- Factors like labor costs, energy prices, and environmental regulations can further influence these figures.



Albemarle's strategic outlook in early 2023 cited $20,000 as the minimum price required to support over 100 projects

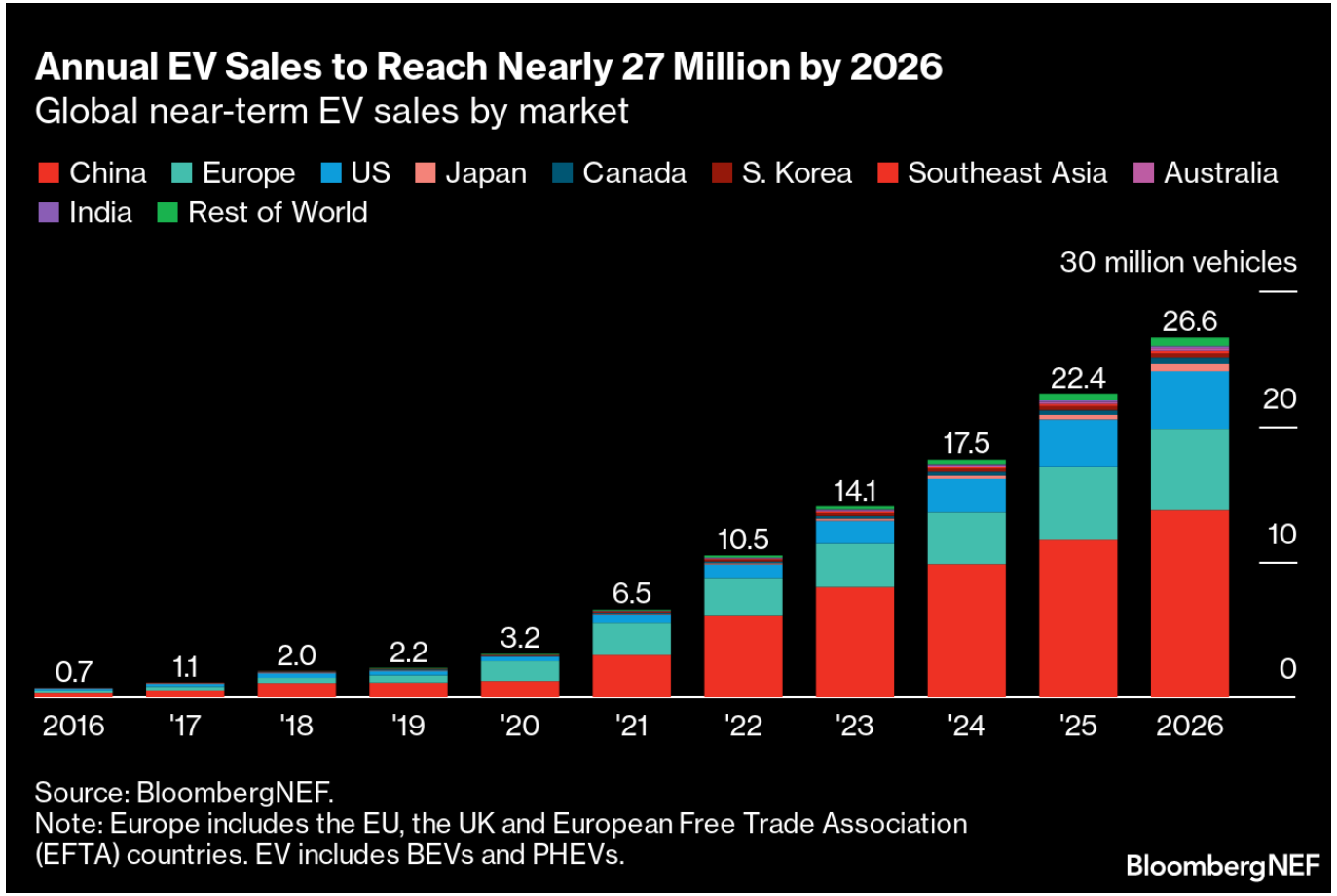


Source: Wood Mackenzie, Bloomberg Intelligence

- **Battery Production:** Companies like CATL, LG Chem, and Panasonic are leading the charge in battery production, consuming over 80% of the global lithium supply. Their production capacities are rapidly expanding to meet the EV demand.
- **Consumer Goods:** From laptops to smartphones and wireless earbuds, major players like Apple, Samsung, and Xiaomi rely on lithium-ion batteries, adding to the growing demand.

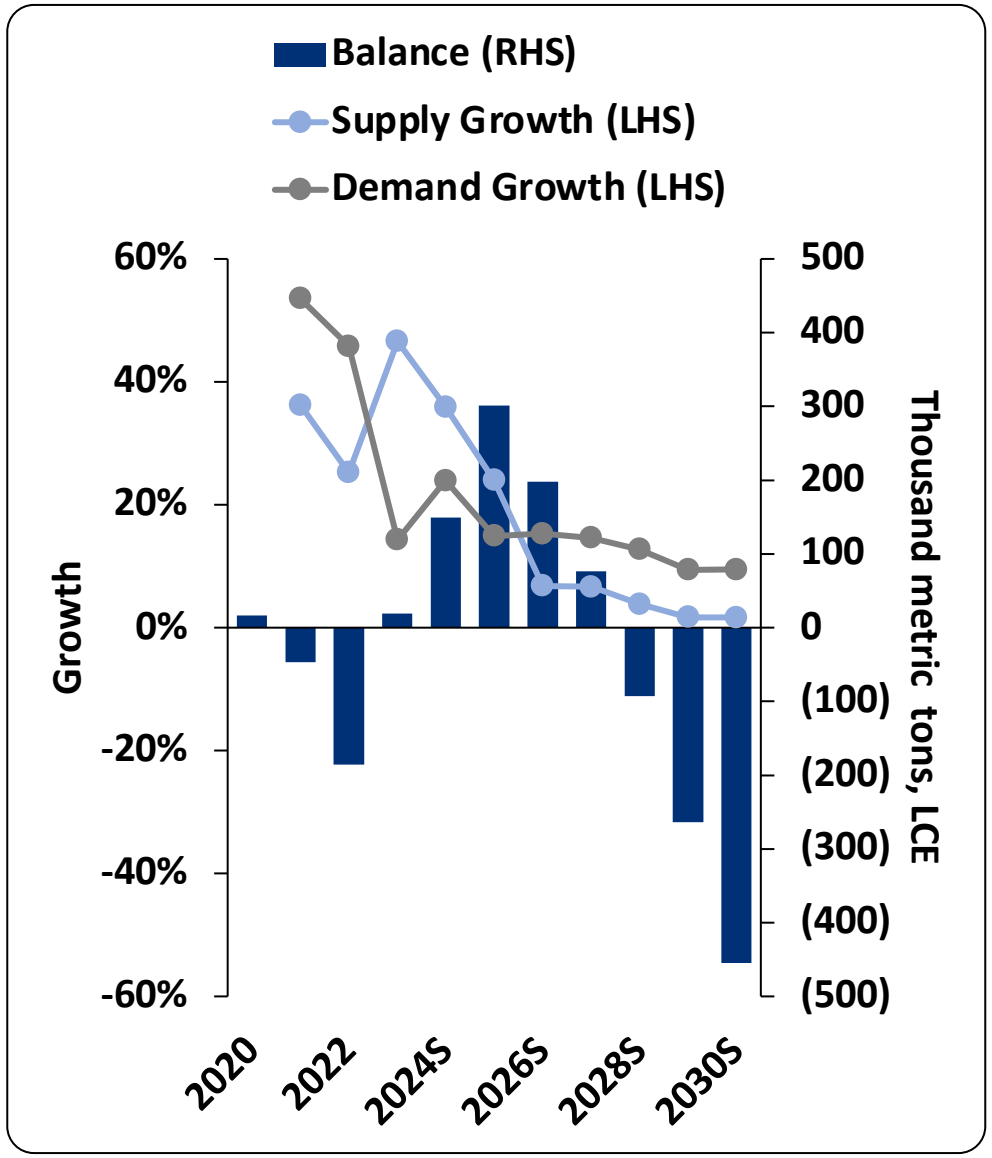
Demand Factors - EV

- Global EV sales are expected to reach 30 million by 2030, **translating to a tenfold increase in lithium demand** compared to 2022.



Long-Term Demand to Soar on EV Adoption (BloombergNEF)

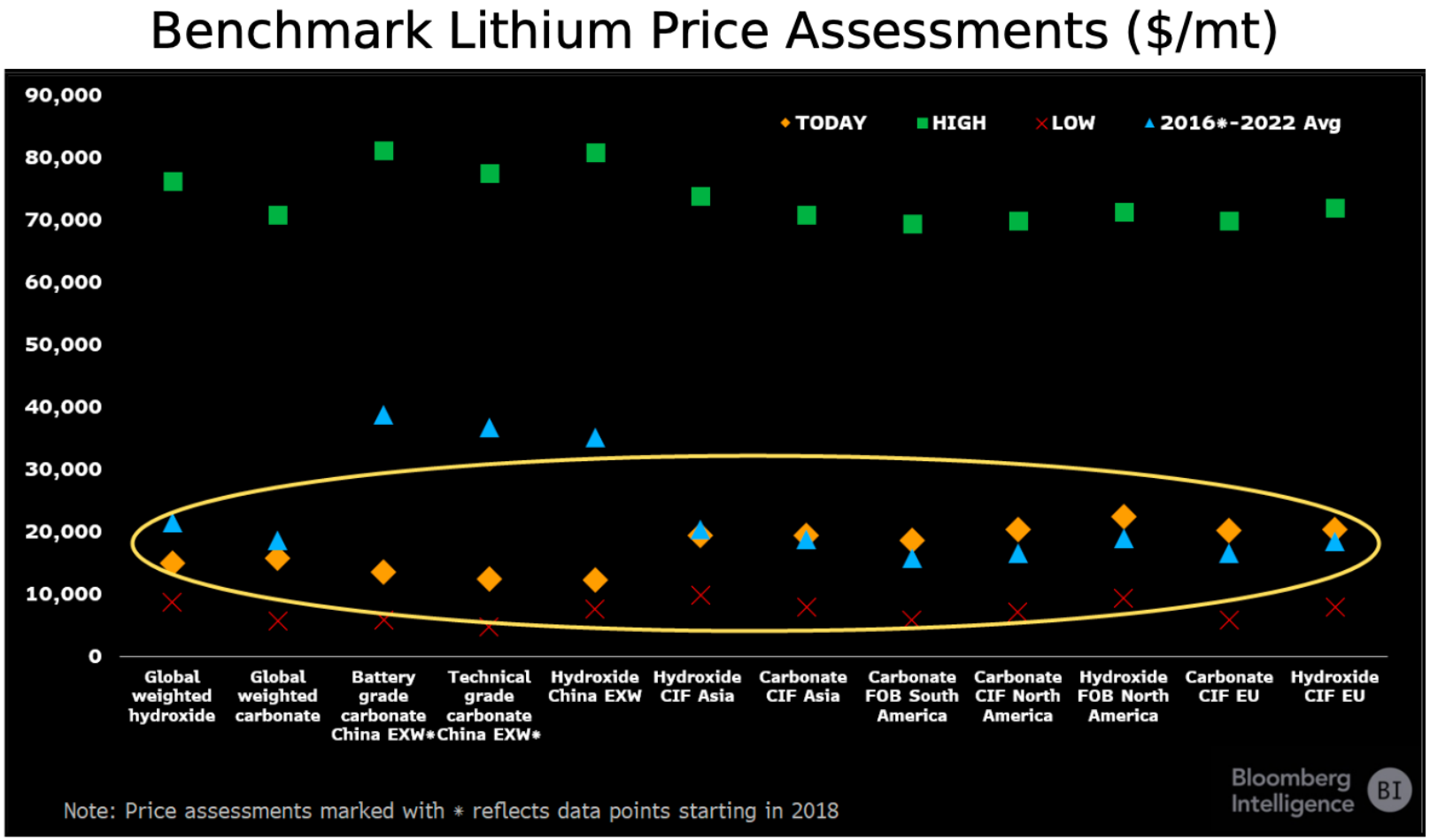
- Required lithium **demand could jump 160%** to 2.6 million tons of lithium carbonate equivalent globally **by 2030**, for compound **annual growth of 15%,** according to modeling by BloombergNEF.
- This is primarily due to the rise of **EVs**, which **made up 69% of demand in 2023**. That could rise to **81% by 2030**. BloombergNEF upgraded demand forecasts in 2H23 due to the anticipated impact of the US Inflation Reduction Act on stationary energy storage and EV purchases.
- China’s retail passenger EV sale could **leap 24%** in 2024. Due to generous **tax incentives** and **aggressive model rollouts.**



What's next?

- Global Lithium Prices **Bottoming**, Yet 2024 **Upside Seems Limited** Weaker-than-expected demand, persistent destocking across the battery supply chain and ramping new supply pushed spot lithium prices down about 80% last year, likely removing meaningful downside risk in 2024. Though underlying demand trends remain intact, significant supply **surpluses over the next two years may keep a tight lid** on global prices.

Historical v.s. Spot



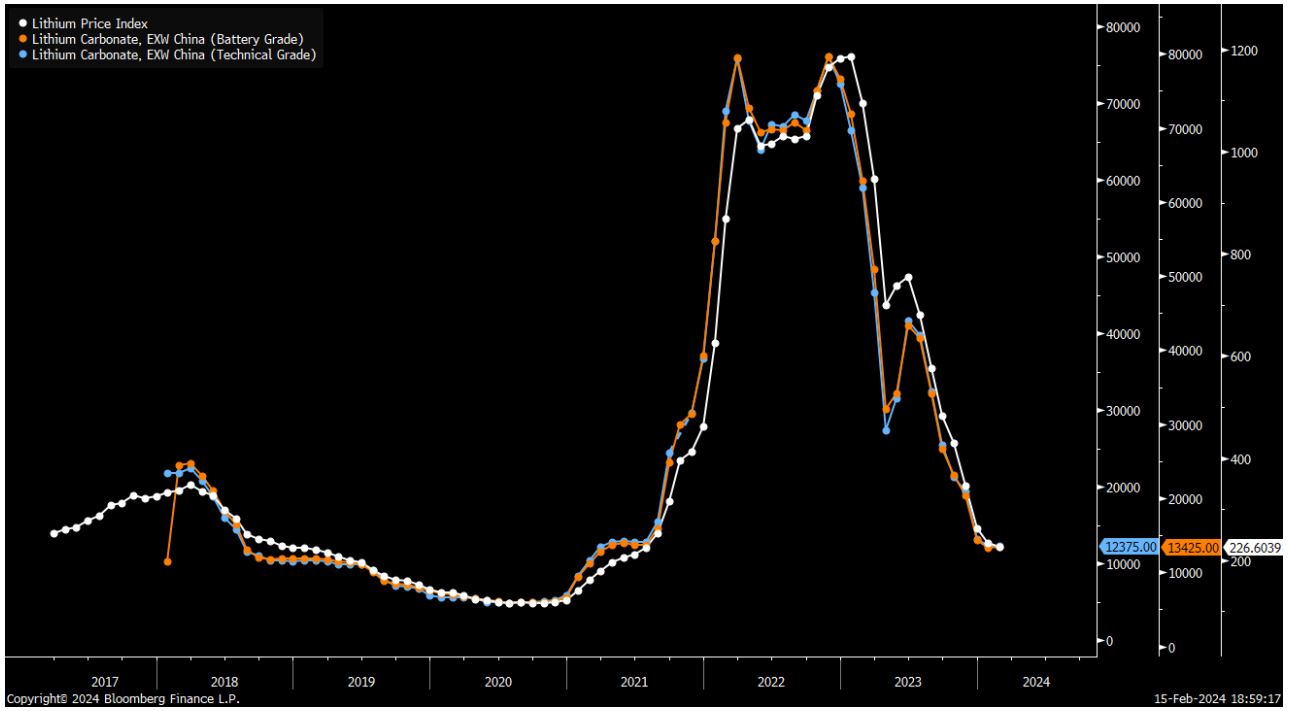
Source: Benchmark Minerals, Bloomberg Intelligence

Indicators I: Increased Importation

- Lithium carbonate imports into China improved towards the end of 2023, rising 29% to 48,139 metric tons in the three months to December, **up 49% year-on-year**.
- Japan's lithium carbonate imports rose 20% to 4,238 tons in the three months to December, **up 59% year-on-year**.
- China and Japan have large refining capacity with lithium carbonate as a feedstock, so imports can potentially provide some indication of global demand.

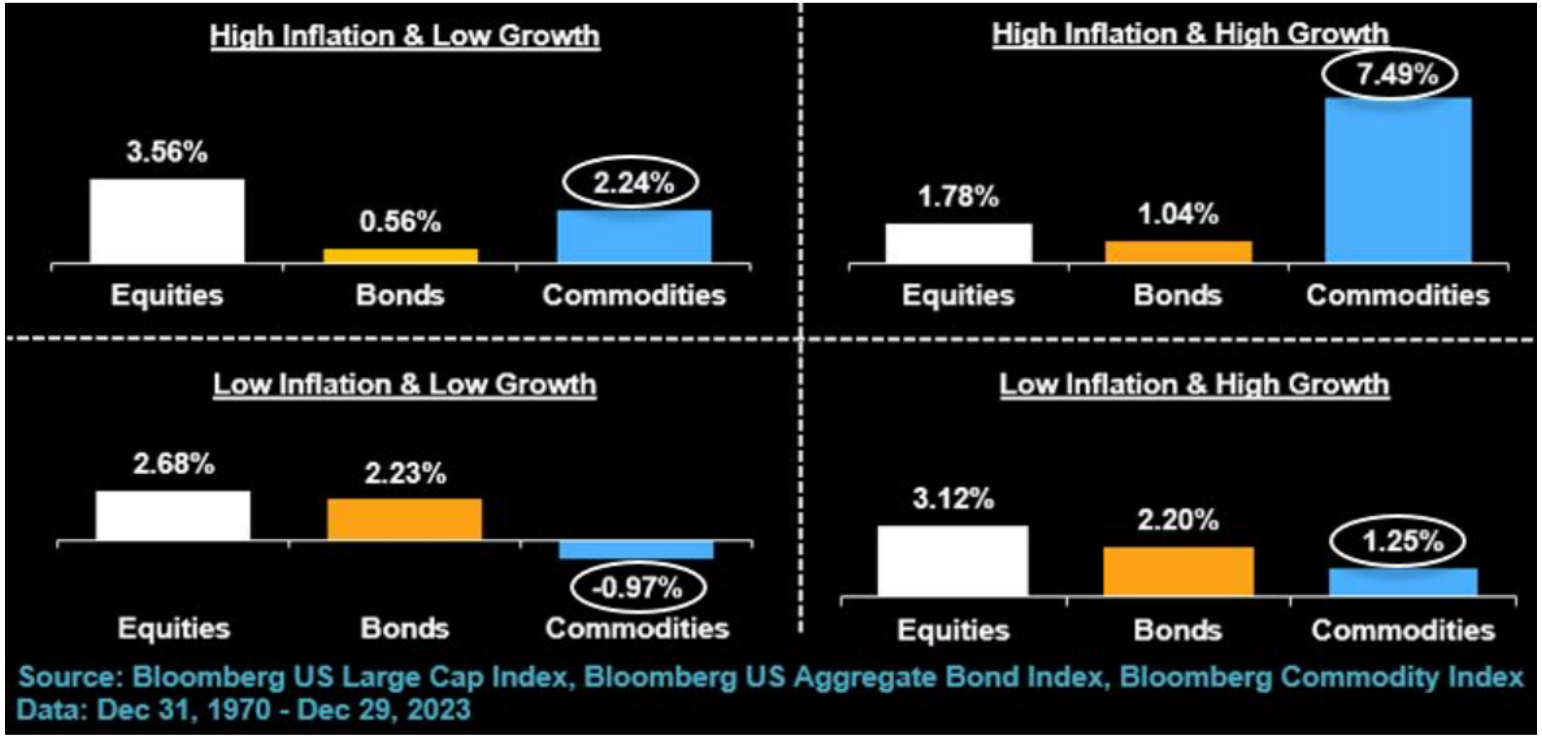
Indicators II: More on China

- Lithium carbonate prices in China -- both battery and technical grade -- continued to move lower through December and early January, a **negative near-term signal** to the global market that soft demand could persist and limit the need to restock inventories.
- Protracted destocking last year exacerbated weaker-than-expected demand -- particularly in 2H -- and contributed to a greater than 80% decline for these important benchmarks.
- Prices in China are often viewed by the industry as the **spot market for lithium** and therefore a clear **leading indicator** of where other regional, contracted markets could be headed.



Indicators III: Economics

- US soft landing consensus vs. China ramping up economic stimulus as prerequisite for base metals bottom
- The higher stocks rise, the less impetus for rate cuts



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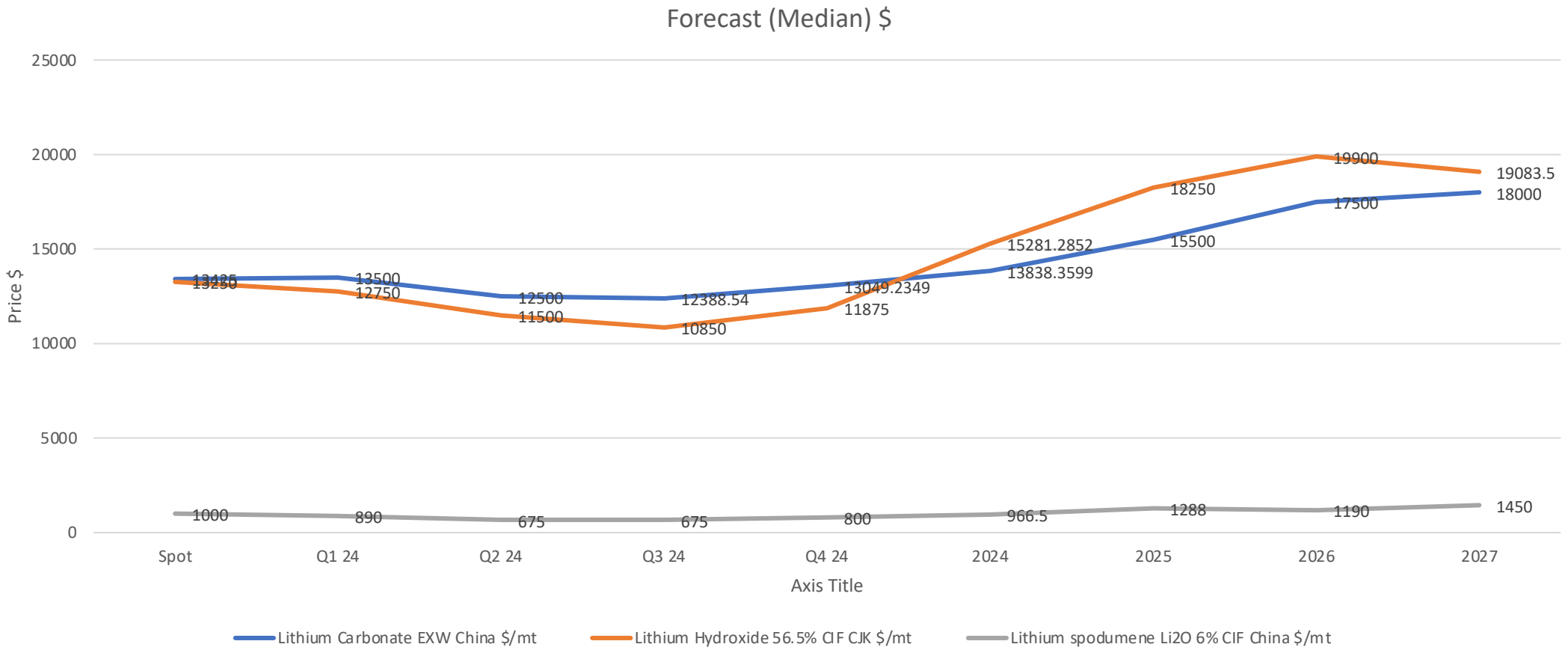

Forecast (Median) $
25000
20000
15000
10000
5000
0
Price $
13250
13500
12750
12500
11500
12388.54
10850
13049.2349
11875
15281.2852
13838.3599
15500
17500
18250
19900
19083.5
18000
1000
890
675
675
800
966.5
1288
1190
1450
Spot
Q1 24
Q2 24
Q3 24
Q4 24
2024
2025
2026
2027
Axis Title
Lithium Carbonate EXW China $/mt
Lithium Hydroxide 56.5% CIF CJK $/mt
Lithium spodumene Li2O 6% CIF China $/mt

Different players in the derivatives world

LITHIUM HYDROXIDE - COMMODITY EXCHANGE INC. Code-189691

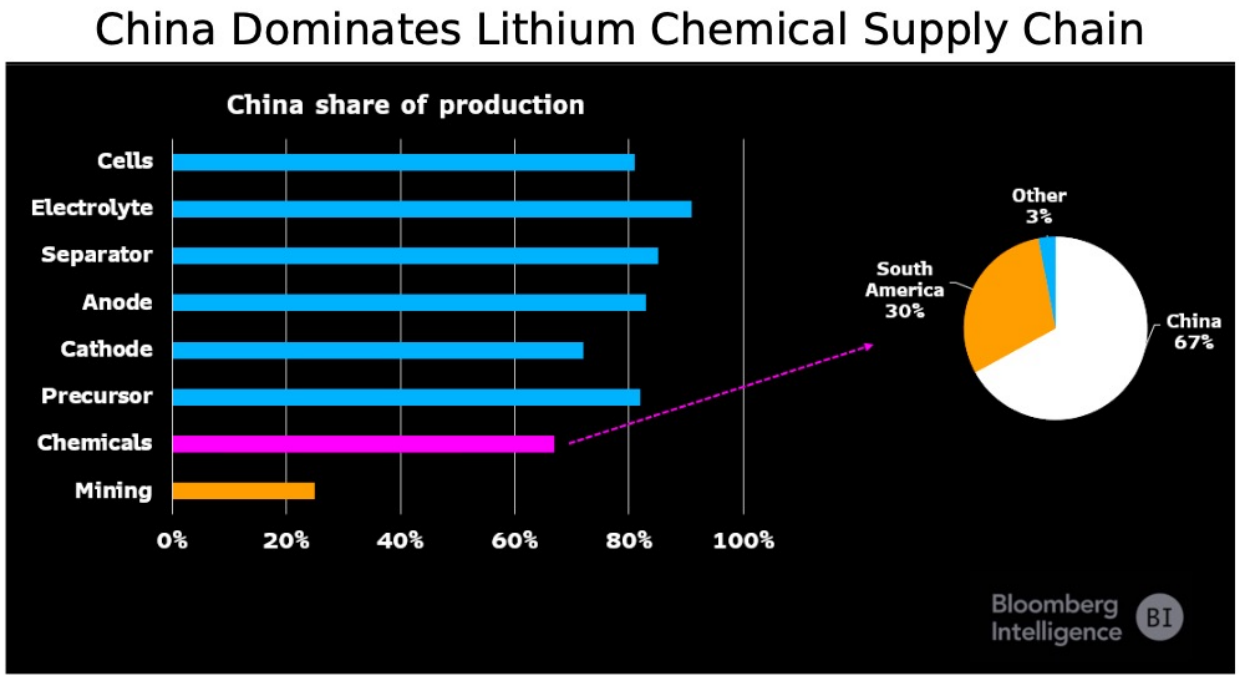
Disaggregated Commitments of Traders - Futures Only, February 06, 2024

	Open Interest	Reportable Positions: Producer/Merchant/ Processor/User Long	Producer/Merchant/ Processor/User Short	Swap Dealers Long	Swap Dealers Short	Swap Dealers Spreading	Managed Money Long	Managed Money Short	Managed Money Spreading	Other Reportables Long	Other Reportables Short	Other Reportables Spreading	Nonreportable Positions Long	Nonreportable Positions Short
	(1000) Kilograms													
	Positions													
All	19,882	2,788	2,807	7,464	321	0	7,018	3,401	0	2,300	12,524	0	312	829
Old	19,882	2,788	2,807	7,464	321	0	7,018	3,401	0	2,300	12,524	0	312	829
Other	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Changes in Commitments from: January 30, 2024													
	313	-116	85	292	-43	0	289	410	0	-227	-129	0	75	-10
	Percent of Open Interest Represented by Each Category of Trader													
All	100.0	14.0	14.1	37.5	1.6	0.0	35.3	17.1	0.0	11.6	63.0	0.0	1.6	4.2
Old	100.0	14.0	14.1	37.5	1.6	0.0	35.3	17.1	0.0	11.6	63.0	0.0	1.6	4.2
Other	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Number of Traders in Each Category													
All	37	.	4	4	.	0	.	7	0	.	16	0		
Old	37	.	4	4	.	0	.	7	0	.	16	0		
Other	0	0	0	0	0	0	0	0	0	0	0	0		

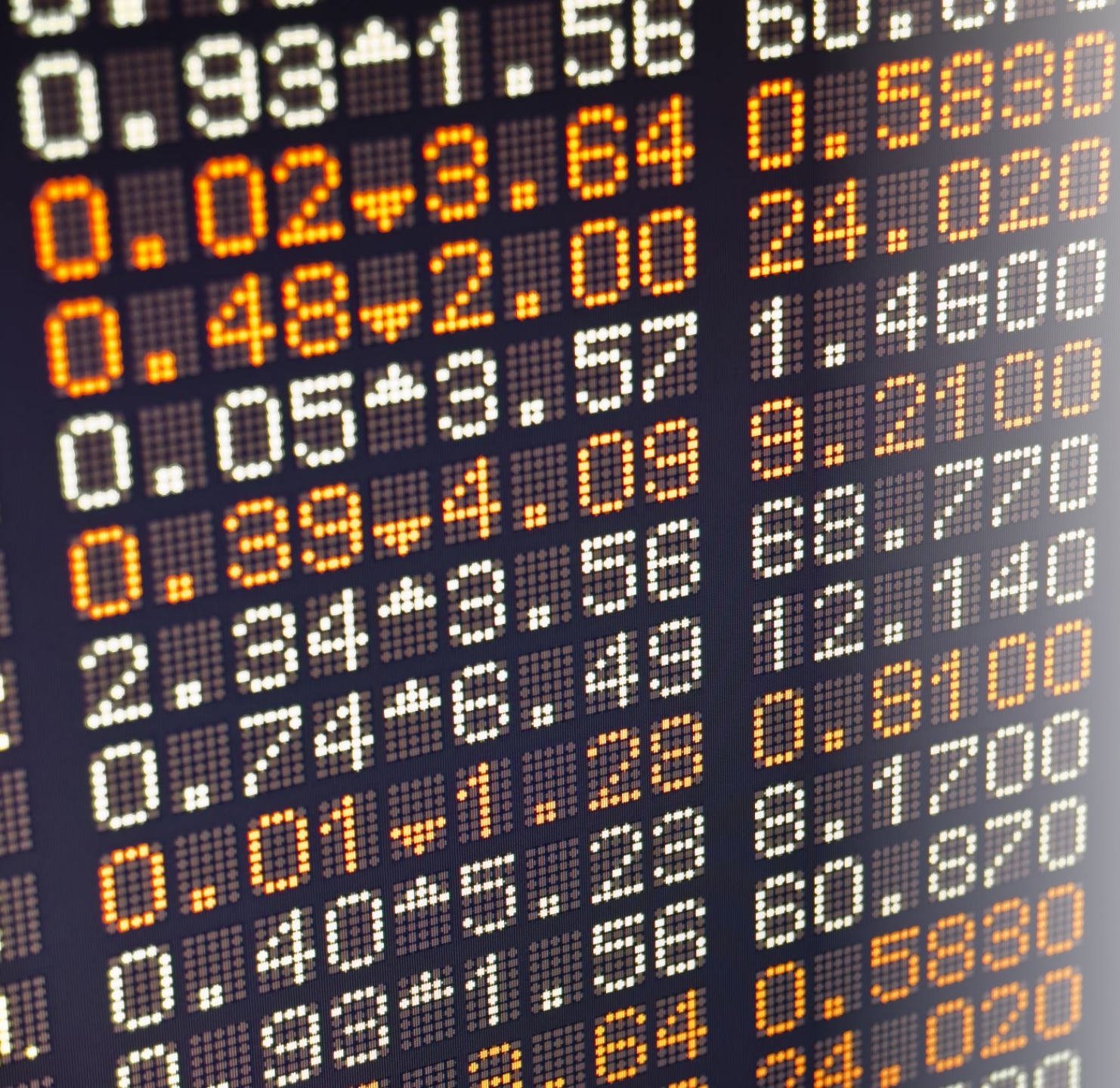
Percent of Open Interest Held by the Indicated Number of the Largest Traders	By Gross Position				By Net Position			
	4 or Less Traders Long	4 or Less Traders Short	8 or Less Traders Long	8 or Less Traders Short	4 or Less Traders Long	4 or Less Traders Short	8 or Less Traders Long	8 or Less Traders Short
All	62.7	46.3	97.2	67.7	62.7	46.3	97.2	67.7
Old	62.7	46.3	97.2	67.7	62.7	46.3	97.2	67.7
Other	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

China Holds Lead in Lithium Conversion

- Looking at the battery supply chain from a holistic perspective, including the ability to convert lithium raw material into battery-grade chemicals, it becomes clear that China has a tremendous head start compared with the rest of the world. Despite China not having the best-quality lithium raw-material deposits, it accounts for about **65% of global lithium chemical supply.**
- To secure access to quality raw materials, domestic companies such Tianqi and Ganfeng have **invested** in some of the best assets in Australia and South America -- a **trend** that's likely to continue.



Source: Wood Mackenzie, Bloomberg Intelligence

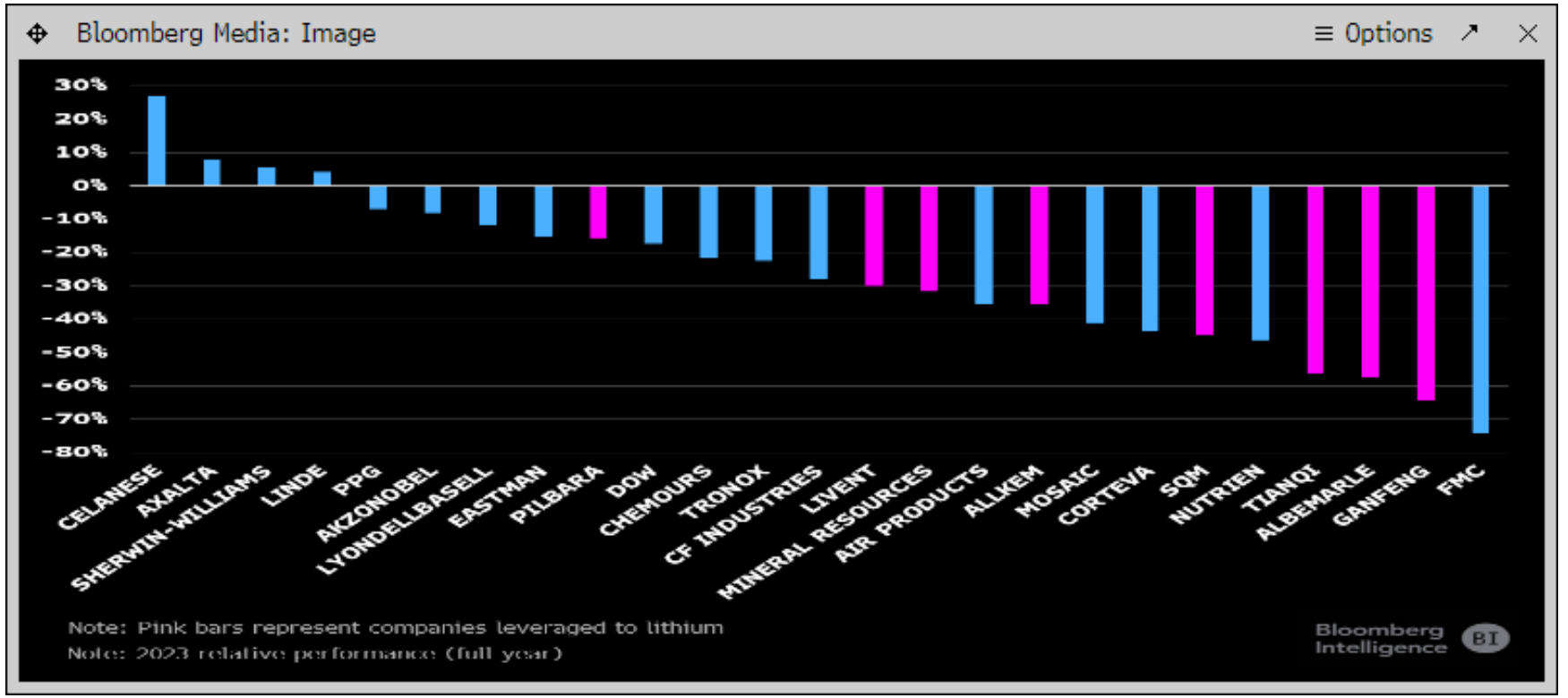


Companies' Volatility Persist

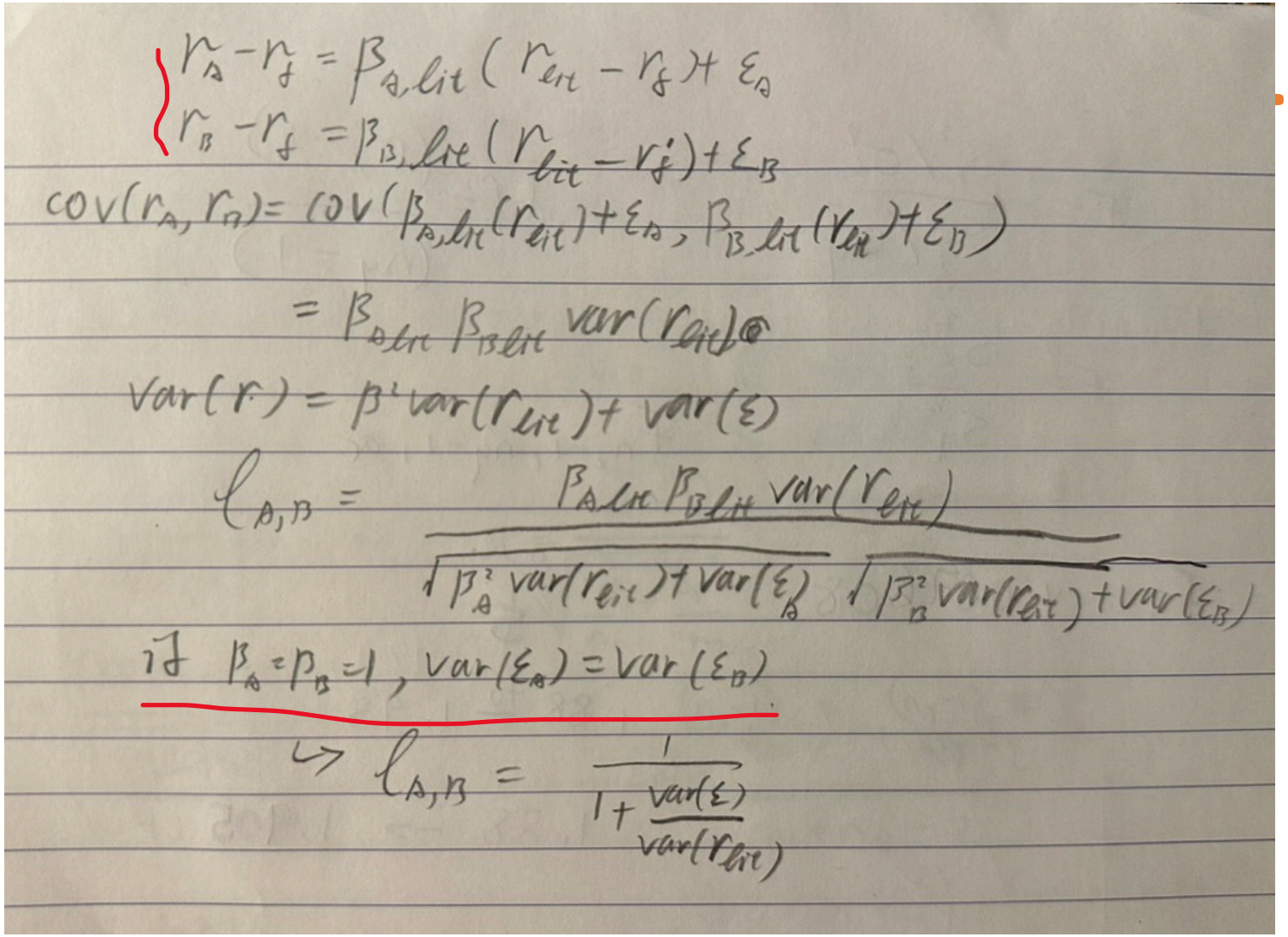
- Lithium companies' share volatility will likely remain elevated in 2024. As the rapidly growing and changing industry grapples with **spot-price sensitivity, evolving technology, M&A(rate) and differing views on supply-demand fundamentals.**
- Top-down-heavy on production
- China? 2024 Presidential Election? Trade War?

Industry Performance

- Industrial, especially lithium has underperformed the market.
- 1-year return: 14% (Industrial) v.s. 23% (S&P500)
- Worst Comparative performance against the material sector XLB



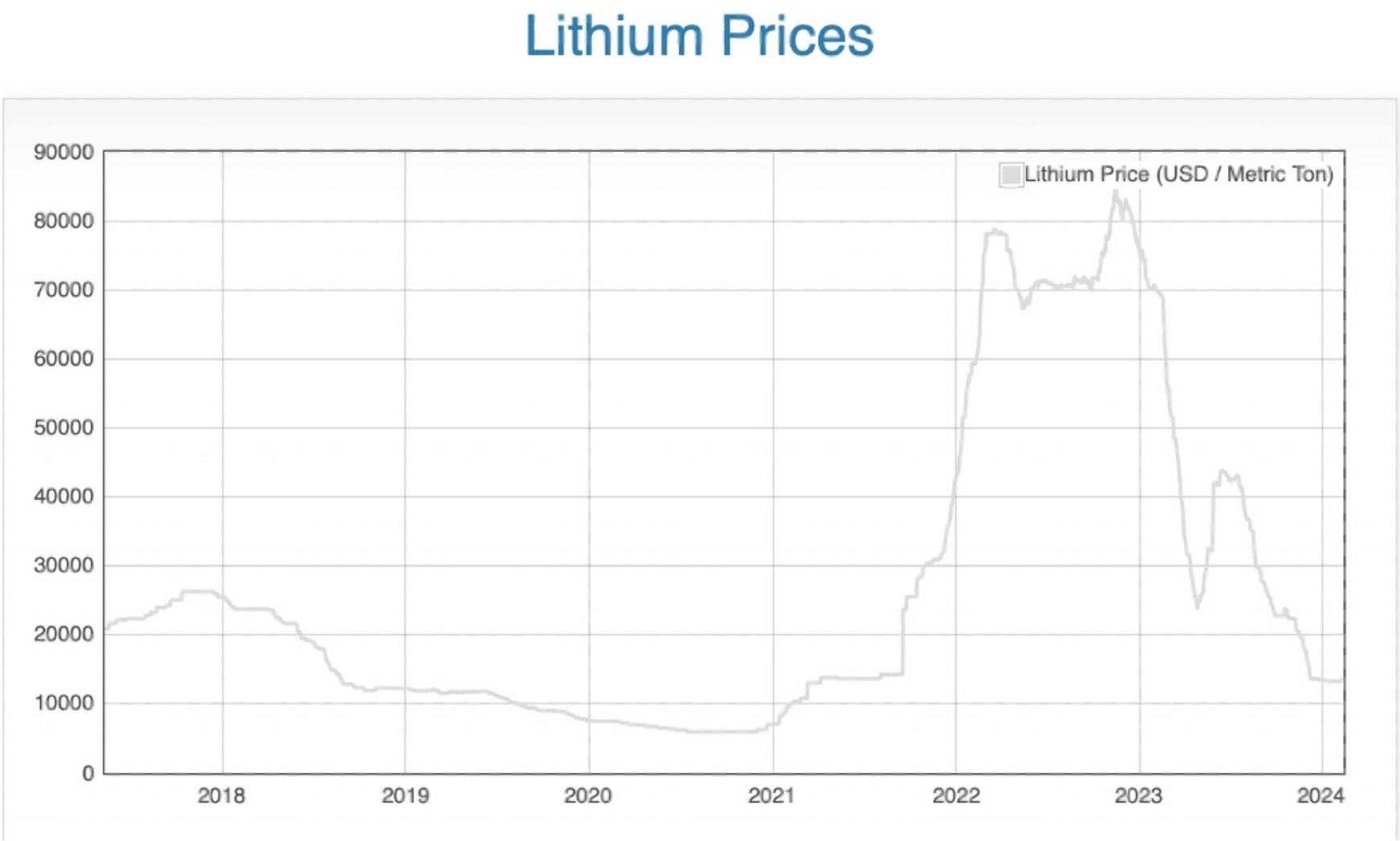
Rich Volatility on the ETFs?



$$\sigma_p^2 = \sum_{f=1}^{K} \beta_{p,f}^2 \cdot \sigma_f^2 + 2 \sum_{f \neq g} \beta_{p,f}\beta_{p,g} cov(r_f, r_g)$$

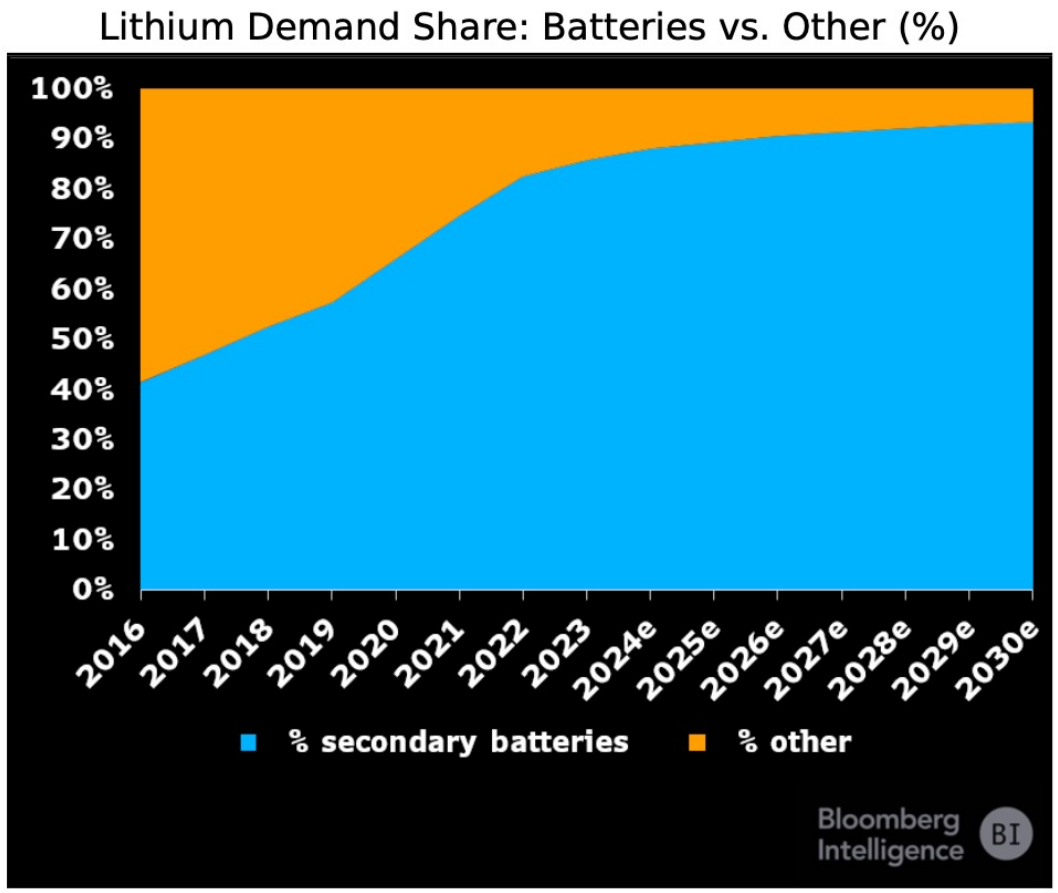
$$\sigma_p^2 = \beta' \Sigma \beta$$

Case Study


Lithium Prices
Lithium Price (USD / Metric Ton)
90000
80000
70000
60000
50000
40000
30000
20000
10000
0
2018
2019
2020
2021
2022
2023
2024

What happened to batteries?

- The supply constraints that characterized the lithium industry -- particularly in 2021-22 -- can be attributed largely to the **short, dramatic shift in demand drivers** -- namely to the high-growth secondary (rechargeable) battery market from GDP-type industrials. The step change was primarily due to higher electric-vehicle adoption and production rates.
- **In 2015, roughly 35% of lithium demand** was from the battery market. As late as 2017, secondary batteries were still less than 50% of total lithium demand. In 2023, secondary batteries may have accounted for roughly 85% of lithium demand and will likely rise to above **90% by the end of the decade**.



Source: Wood Mackenzie, Bloomberg Intelligence

Supply and demand factor dominates

- The lithium market's recent **boom-bust** cycle (2022 boom; 2023 bust) lends further weight to the argument that lithium is a **true commodity and not a highly specialized chemical.**
- Qualified, battery-grade material exhibits a number of characteristics aligned with that of a specialty chemical, but the market doesn't appear willing to underwrite that view.
- This likely signals that **pricing will remain cyclical, largely dictated by supply-demand dynamics** and prone to periods of significant mismatches. **Pricing floors** will likely be driven by the **cost curve**, with lower-quartile producers like Albemarle remaining advantaged.