



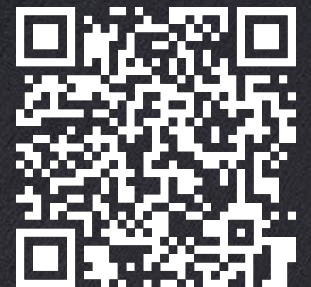
# The Role of Raw Materials in the Battery Economy

Challenges in Energy Materials Extraction and Processing

Andrew Miller, COO  
Benchmark Mineral Intelligence

NAATBatt 2024  
Tuesday 20 February 2024

[www.benchmarkminerals.com](http://www.benchmarkminerals.com) | [info@benchmarkminerals.com](mailto:info@benchmarkminerals.com)

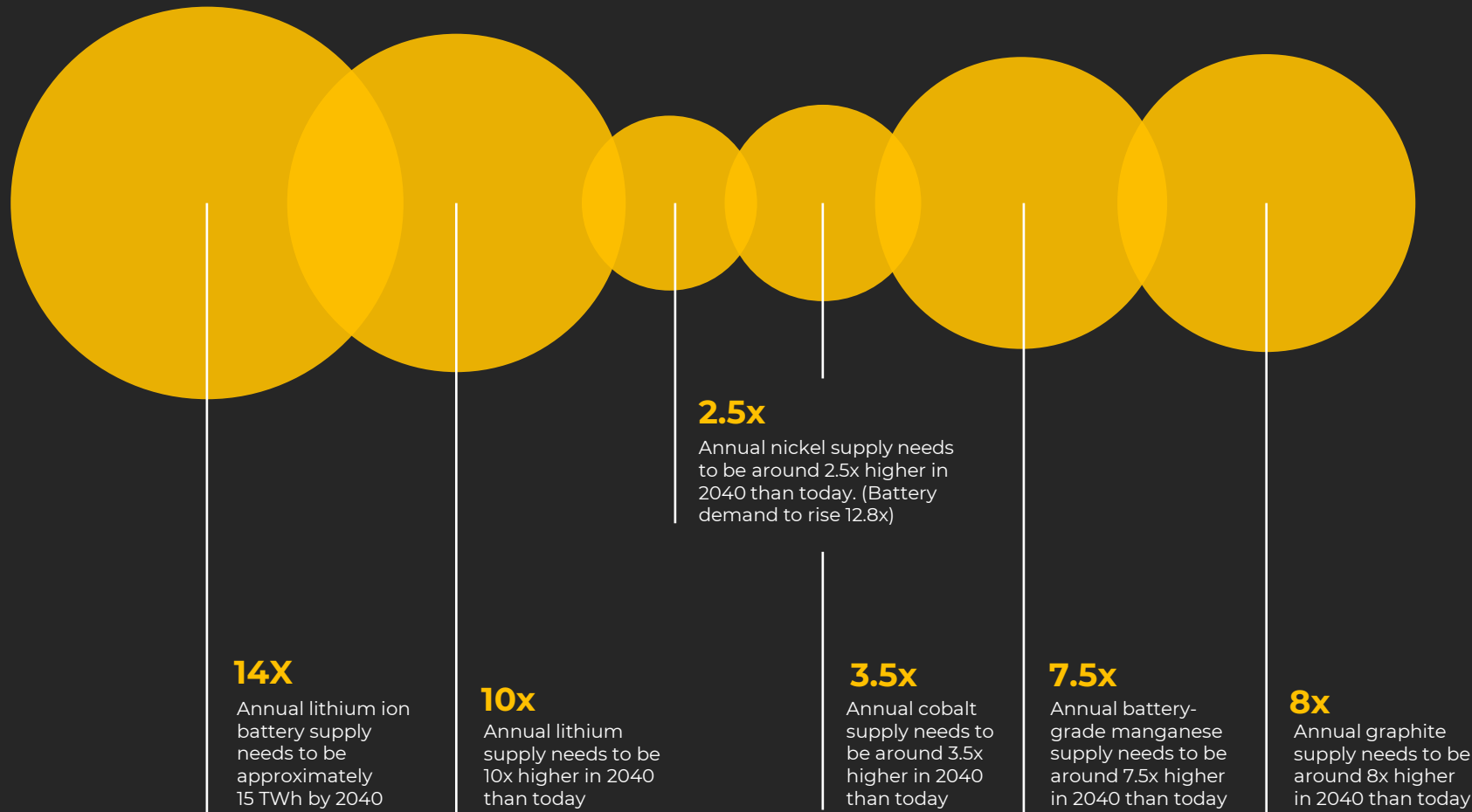


**HQ:** London, UK | **Offices:** Brisbane, Colombo, Fort Lauderdale, Jakarta, Melbourne, New Delhi, Shanghai, San Francisco, Tokyo, Washington DC

# A Global Energy Revolution is Underway



# The Ability to Reach Net Zero Will Hinge on Scaling Critical Mineral Supply Chains

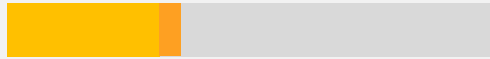


# Batteries Dictate EV competitiveness; Raw Materials Dictate Battery Economics

2025 CADILLAC  
Escalade IQ



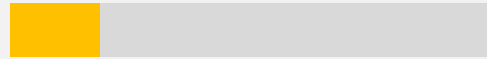
**\$27,700** Battery Price



2023 TESLA  
Model S



**\$11,500** Battery Price



2025 RAM  
1500 REV Limited



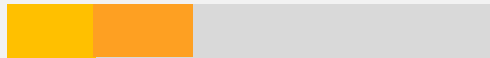
**\$30,400** Battery Price



2022 RIVIAN  
Amazon Delivery Van



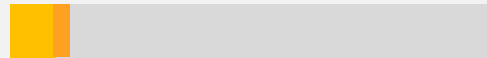
**\$24,300** Battery Price



2023 Ford  
Mustang Mach E Standard



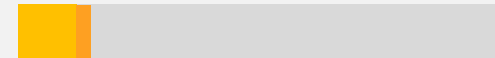
**\$6,100** Battery Price



2023  
VW ID.4 Standard



**\$7,900** Battery Price

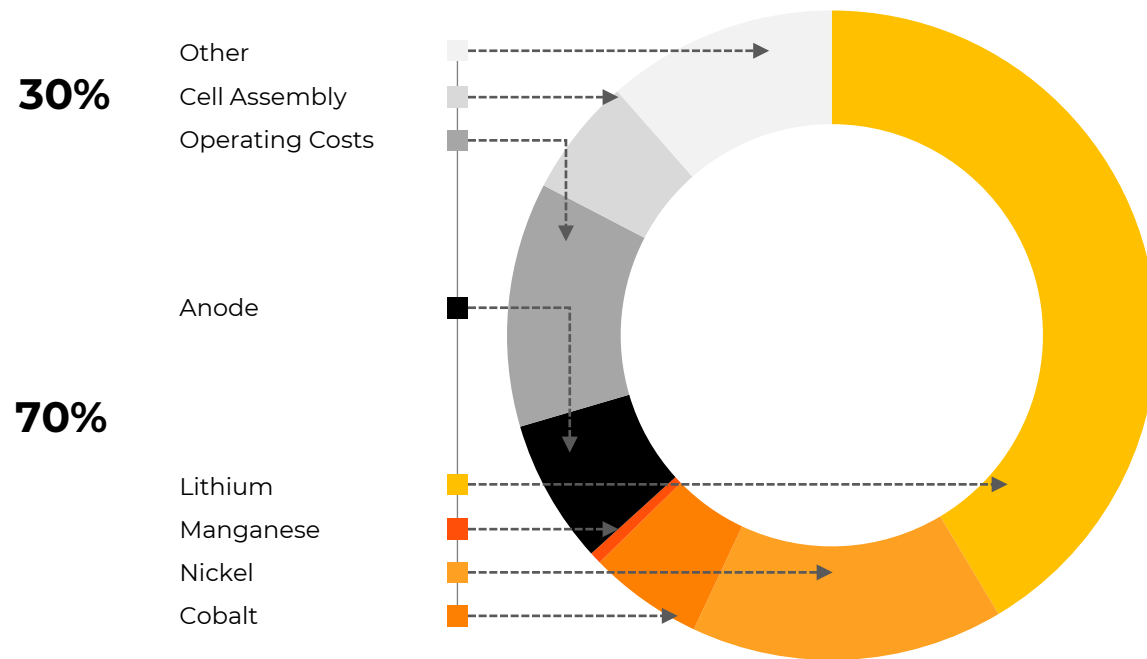


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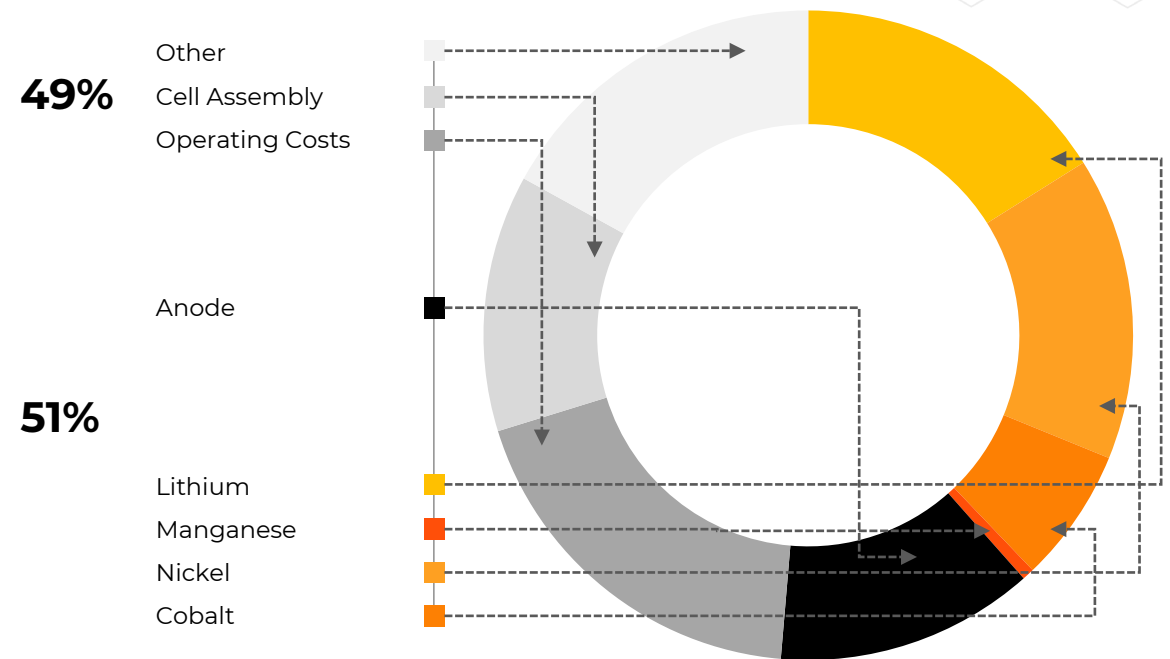


# How Important Are Raw Materials in a Low-Price Environment?

## NMC 622 – Jan 2023

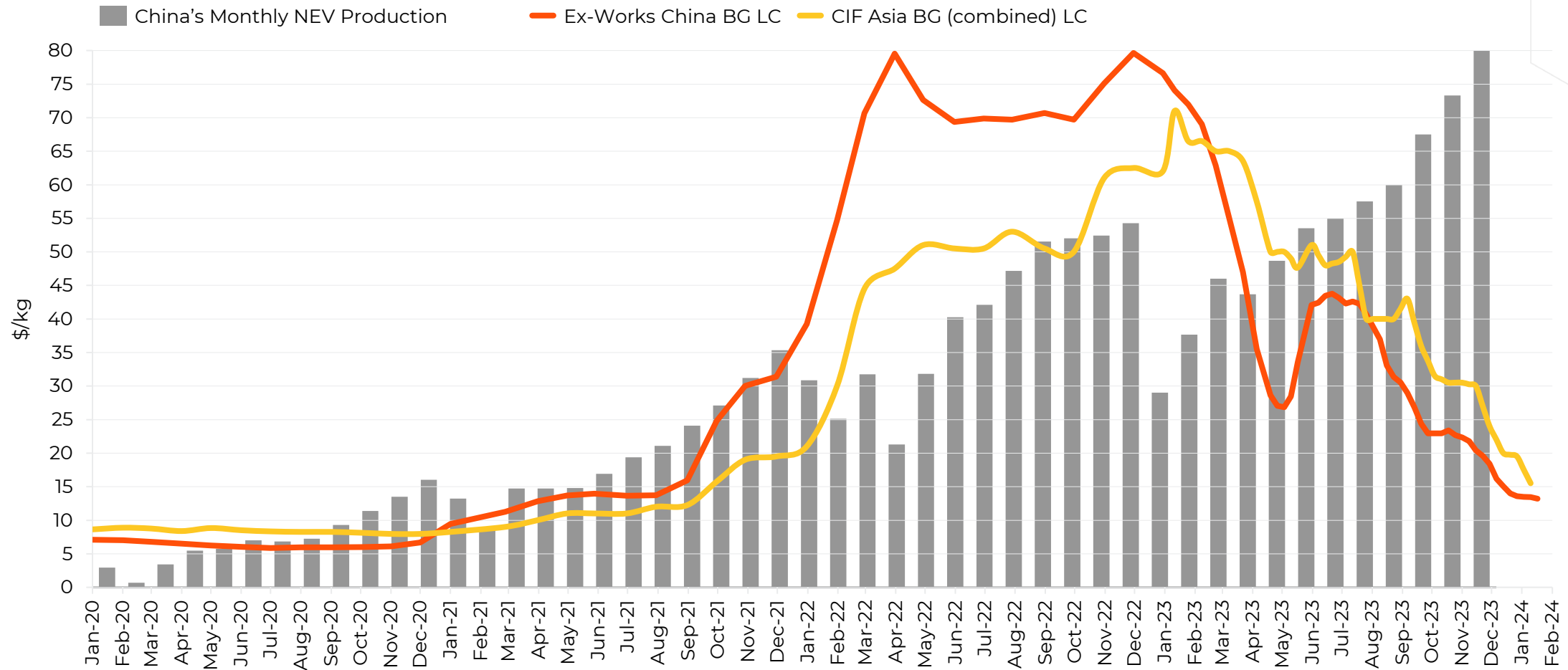


## NMC 622 – Jan 2024



# The Raw Material Price Paradox

Price volatility a reflection of **market immaturity** rather the **supply security**

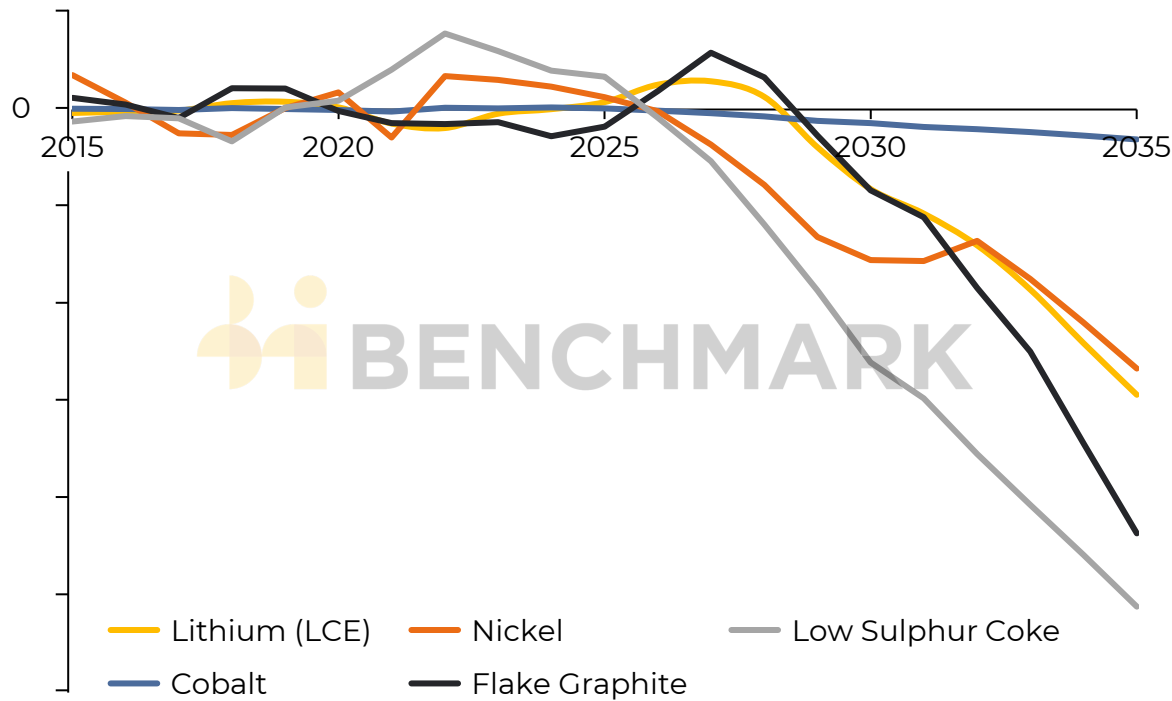


# The False Comfort of Low Prices Only Heightens Prospects of Supply Chain Disruption in the Years Ahead

Even bearish demand projections have key material markets facing structural deficits by late-2020s

## Raw material market balances

kt (weighted)



- ! All battery raw material markets already face **structural challenges** by the end of the decade
- !! **Lead times** for raw material expansions are long, and **often underestimated** relative to demand
- !!! Much of the expected expansions in raw material supply come from **new or untested extraction technologies**

Source: Benchmark Forecasts

# To Address This We Will Need... An Unprecedented Amount of Capital Deployment

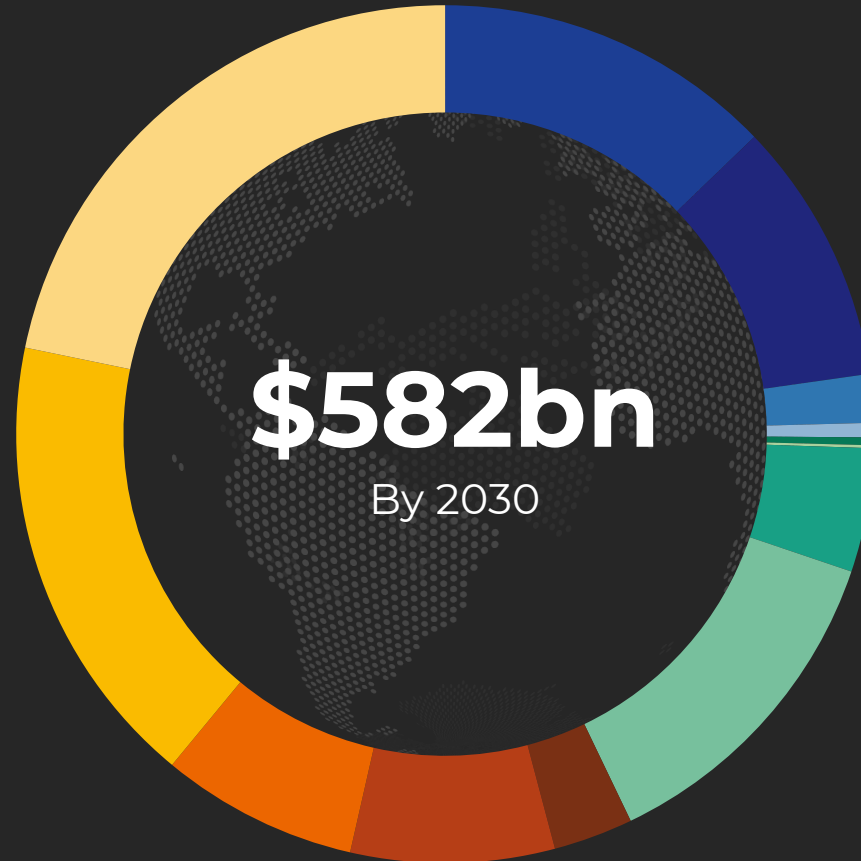
## Downstream

### Battery Materials \$130bn

- Electrolyte/Separator \$44bn
- Cathode \$67bn
- Anode \$19bn

### Batteries \$214bn

- New capacity \$109bn
- Expansions \$105bn

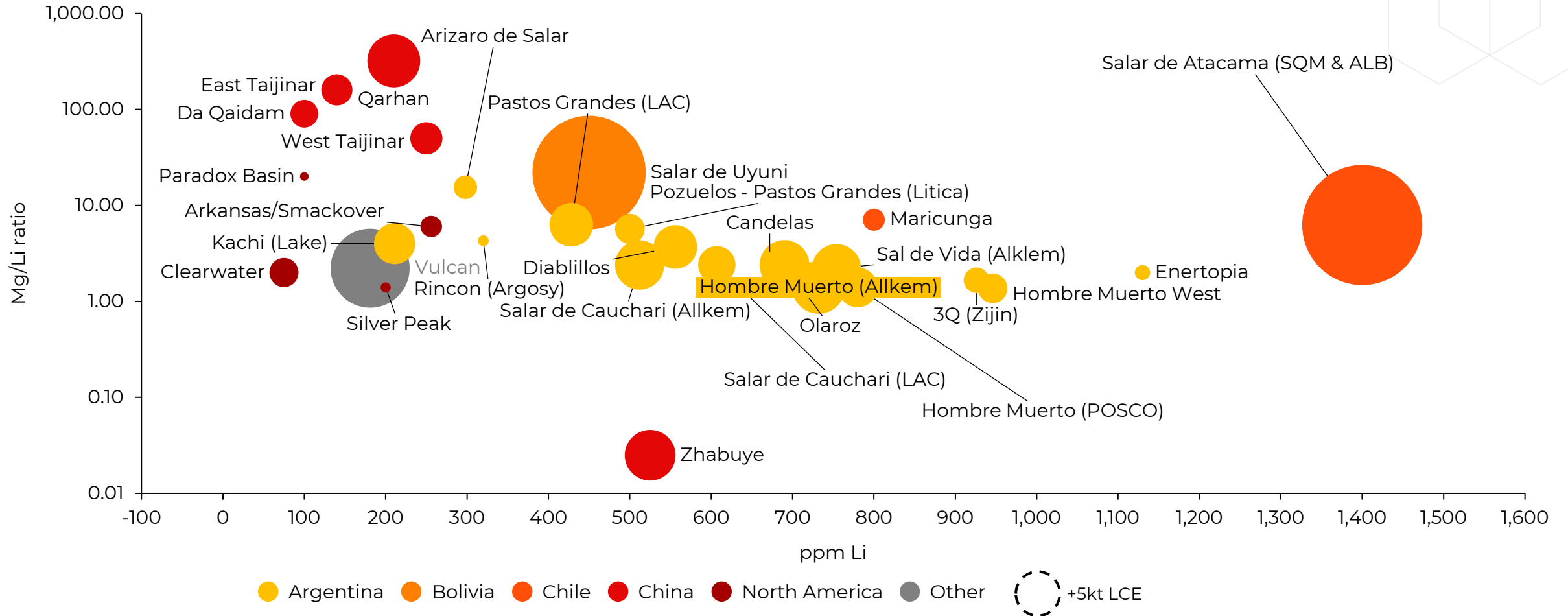


## Upstream

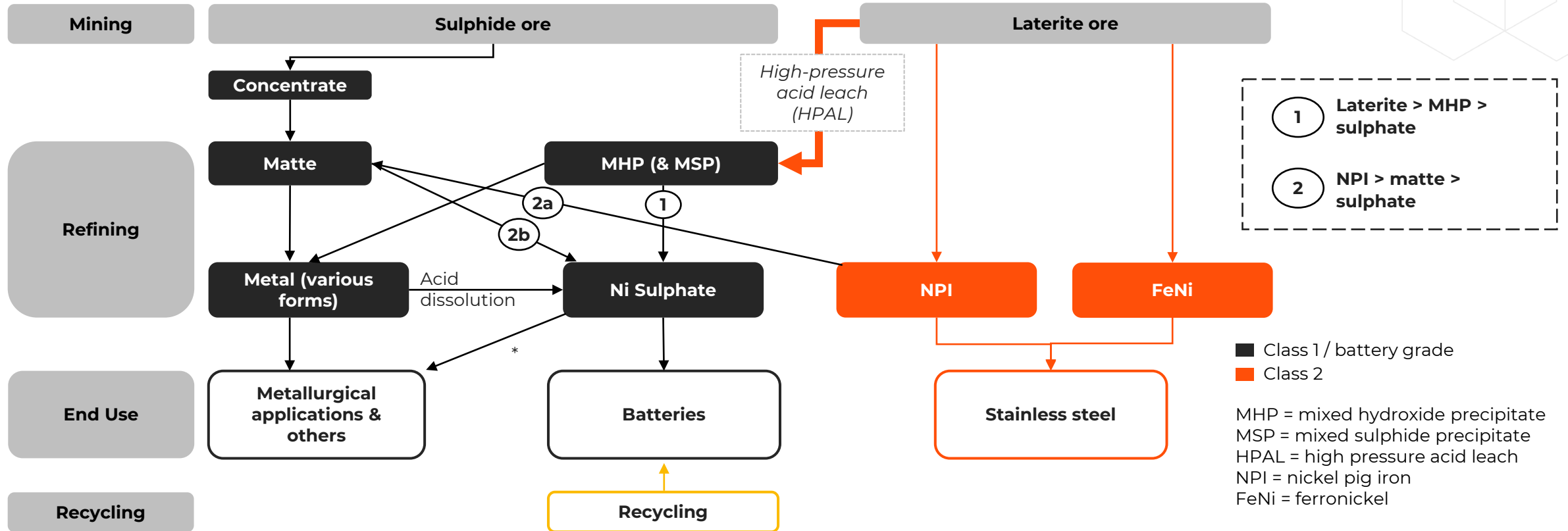
### Critical Raw Materials \$237.5bn

- Nickel \$70bn
- Lithium \$54bn
- Cobalt \$9bn
- Nat Graphite \$3.5bn
- Syn Graphite \$1.8bn
- Manganese \$0.8bn
- Recycling \$24bn
- Other \$75bn

# To Address This We Will Need... Technology Innovation to Unlock Previously Unviable Assets












# To Address This We Will Need... To Leverage Greater Flexibility Over Existing Supply Channels



# To do This We Will Need... Far Greater Participation From Downstream Actors in Upstream Markets














Current supplier
  Future supplier
  Undisclosed/None

OEM	Mining resources			Battery Materials				Batteries
	Lithium	Nickel	Cobalt	Cathode	Anode	Electrolyte	Separators	
	Albemarle, Ganfeng, Yahua	Vale BHP Talon metals	Glencore	Sumitomo	BTR, Shanshan, Chinese suppliers Syrah (2024+)	Mitsubishi Chem, Tinci high-Tech	Sumitomo	Panasonic, LGES, CATL
	Ganfeng, Vulcan Energy (2026+)	Huayou cobalt Tsingshan	Huayou cobalt Tsingshan	Umicore (2025)				LGES, CATL, SDI
				Sumitomo				PPES
	Lithium Americas, Controlled Thermal Resources (2024+)	QPM		POSCO (2024+) BASF	POSCO (2024+)			LGES, CATL
								LGES, SDI, CATL
DAIMLER								SK On, AESC, LGES, CATL
	Vulcan Energy (2026+), Controlled Thermal Resources (2024+)	Terrafame (2025+)						CATL
	Ioneer, Compass, Lioneer	Vale, Huayou, BHP						SK On, LGES, CATL
	Vulcan Energy (2026+)	Terrafame						LGES, AESC
	Ganfeng, Livent		Glencore, Management Group					CATL, SDI, AESC

\*This table indicates public announcements and is not an exhaustive list. For full details, please contact [info@benchmarkminerals.com](mailto:info@benchmarkminerals.com)

# To do This We Will Need... More International Collaboration, & Fairer Ways to Assess Asset-Level Risk

## Indonesia

 Lack of progress against SDGs	Low
 Climate change risk	Medium
 Ecological threat	High
 Water risk	Medium
 Deficiency in environmental performance	Very high
 Governance risk	Medium
 Fragility of civil society and civic freedoms	Medium
 Conflict severity	Medium
 Vulnerability of state to collapse	Medium
 Level of gender-based discrimination	Medium
 Perceptions of danger	Medium
 Policy unattractiveness for mining investment	No data
 Lack of transparency in natural resources sector	Low

ESG Concern Rating:

**Of Concern**

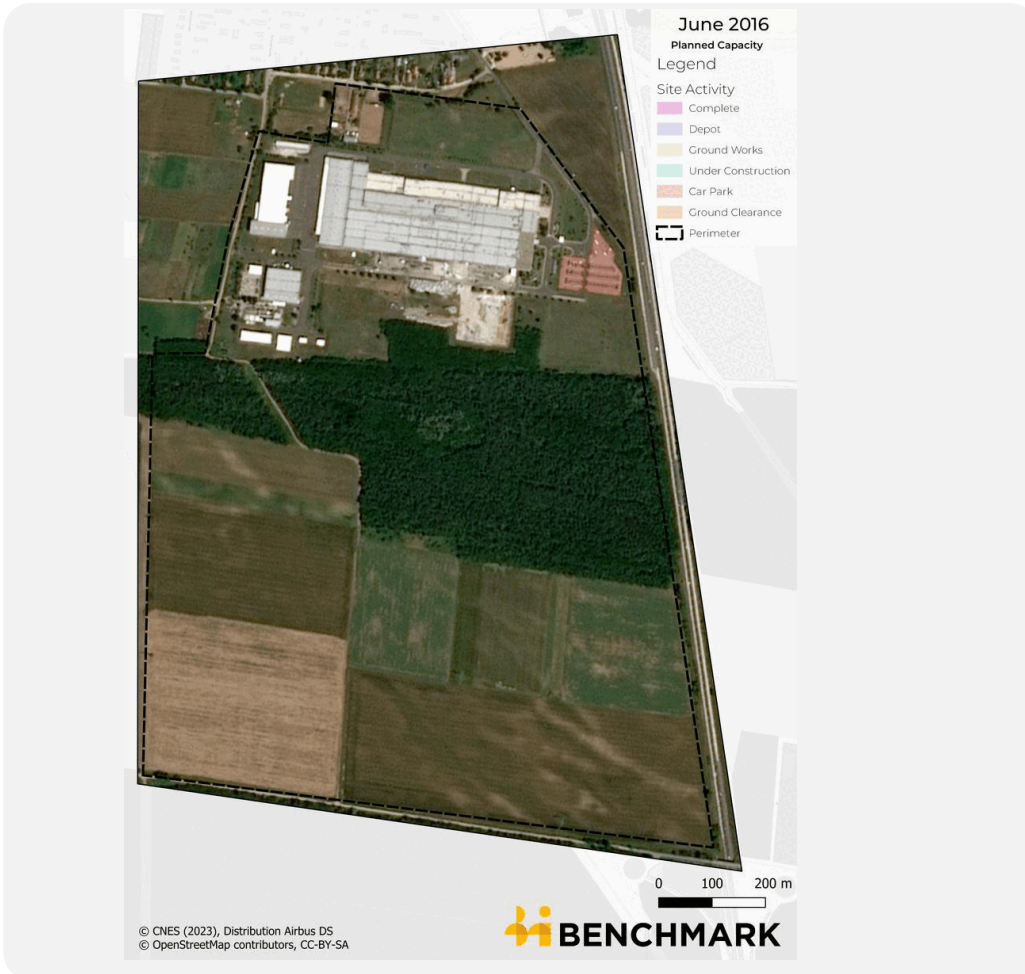
### Benchmark's Nickel Sustainability Index

Industry Leading

Good Practice



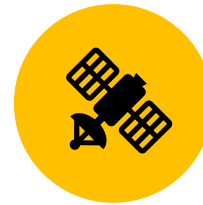
# To Address This We Will Need... A More robust perspective of the demand pipeline



Verified Active Capacity



Verified Capacity Under Construction



**169.5 GWh**



**825.1 GWh**





For any queries, contact us:



[amiller@benchmarkminerals.com](mailto:amiller@benchmarkminerals.com)  
[info@benchmarkminerals.com](mailto:info@benchmarkminerals.com)



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