Fastmarkets: Battery Raw Materials

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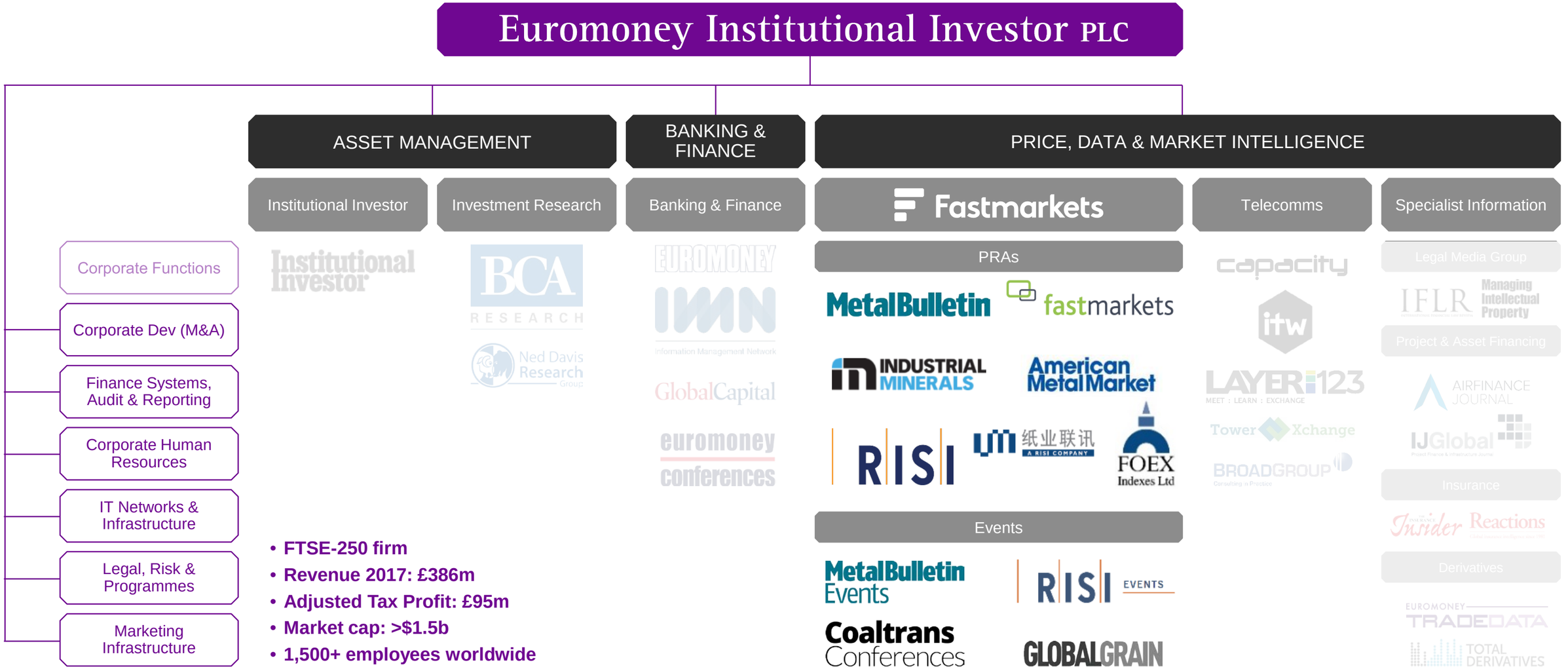
NAATBatt, Phoenix

March 2019

A part of Euromoney – a $1.5 billion market cap FTSE-250 company



Fastmarkets Price Reporting Division

13
GLOBAL OFFICES

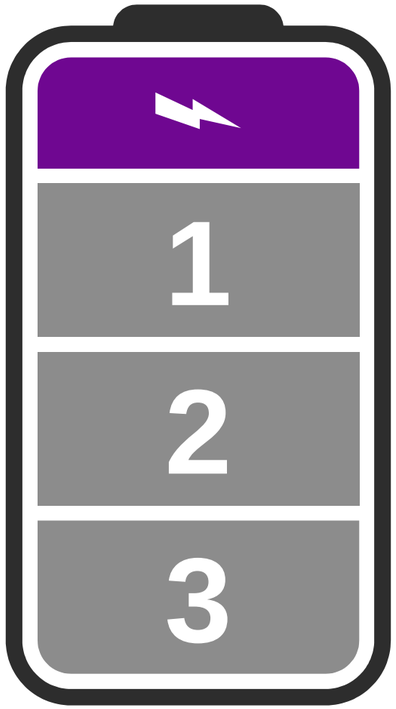
>50
EVENTS

>5,500
PRICES

>50
PRICE REPORTERS IN CHINA

>370
TEAM MEMBERS

>200
FORECASTS



Areas to cover

Fastmarkets price discovery – how we go about it

Why we cover the battery raw material prices we do

Our outlook for **Lithium** and **Cobalt**

Expertise and methodology supported by technology that enhances the reliability of our data

The industry submits transaction & contract prices

Price reporters gather price information

Price reporters enter the source data

Price reporters consider appropriate price & rationale

Supervisors validate or return to price reporter

Fastmarkets publishes the price benchmark

IOSCO COMPLIANT METHODOLOGY & SYSTEMS

Trained price reporters in global locations provide specialist market knowledge

Market data is collected from numerous approved contributors from across the supply chain

MInD

Data is analysed and, if required, normalised. Outliers are removed

Pricing data is entered in to our specially designed pricing database: MinD (Markets Information Database) to ensure a full audit trail

Our integrated peer-review system ensures that all data is verified by at least two reporters to ensure quality control and compliance

Data is published through Price Tracker and our data solutions, made available to subscribers who can be confident about the quality of our prices

BENCHMARKS

OICV-IOSCO

Price assessment process

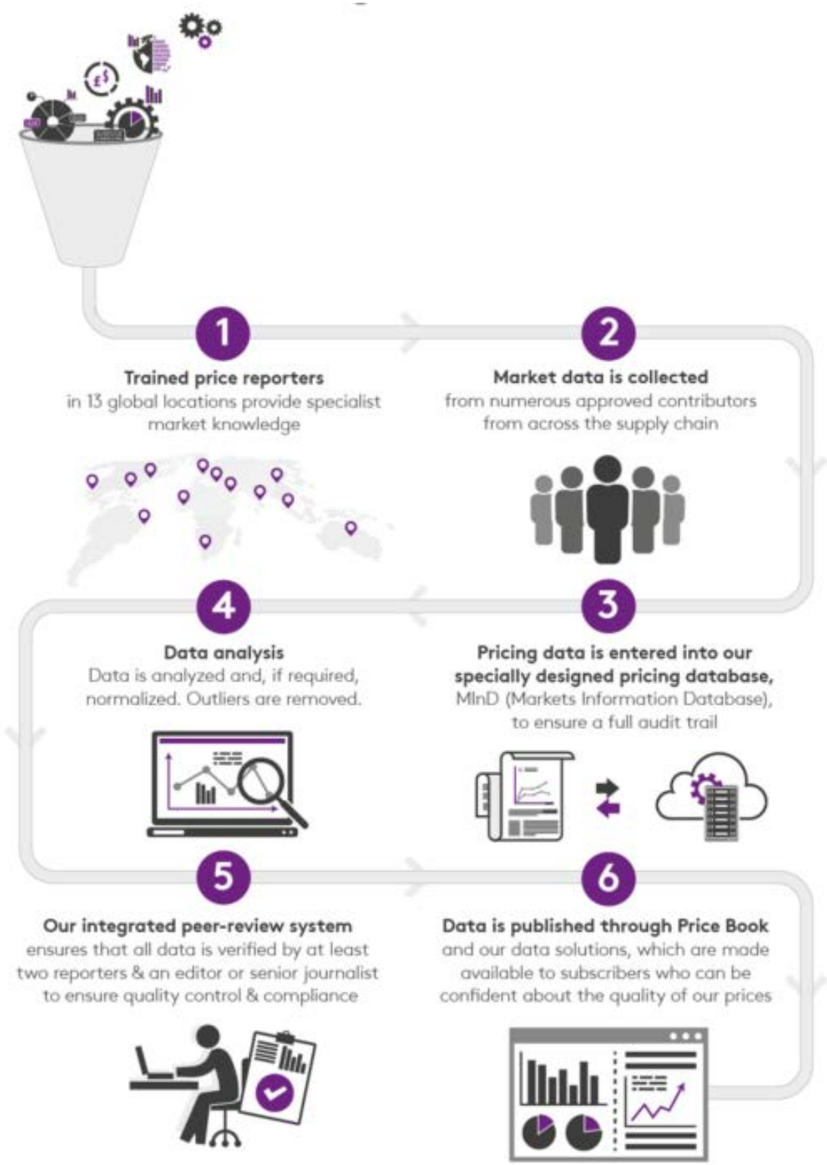
ROBUST

TRANSPARENT

REPLICABLE

TRANSACTION BASED

AUDITABLE



Fastmarkets makes our trade logs available for increased transparency

Tracking increasing liquidity in the carbonate market

LITHIUM TRADE LOG

Price assessed at 113,000-118,000 yuan per tonne

50 tonnes sold between 117,000-118,000 yuan

20 tonnes sold between 125,000-130,000 yuan **(outlier)**

Offer between 117,000-118,000 yuan

Offer between 110,000-115,000 yuan

Offer at 109,000 yuan **(outlier)**

Deal heard at 125,000 yuan **(outlier)**

Prices indicated for 20 tonnes between 115,000-120,000 yuan

Prices indicated for 5 tonnes between 113,000-120,000 yuan

Prices indicated between 115,000-120,000 yuan

Prices indicated between 115,000-120,000 yuan

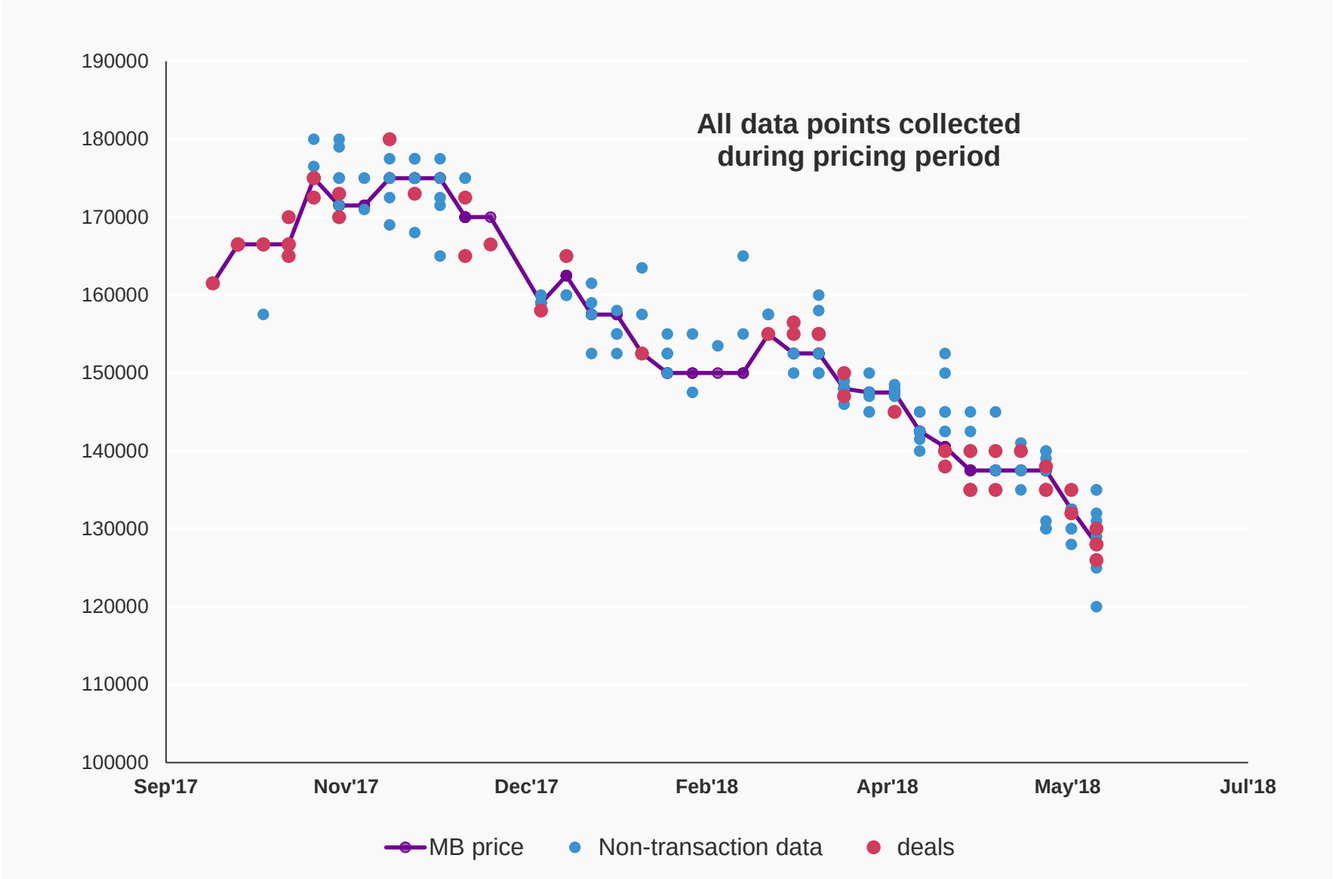
Prices indicated between 113,000-118,000 yuan

Prices indicated between 112,000-118,000 yuan

Prices indicated between 110,000-115,000 yuan

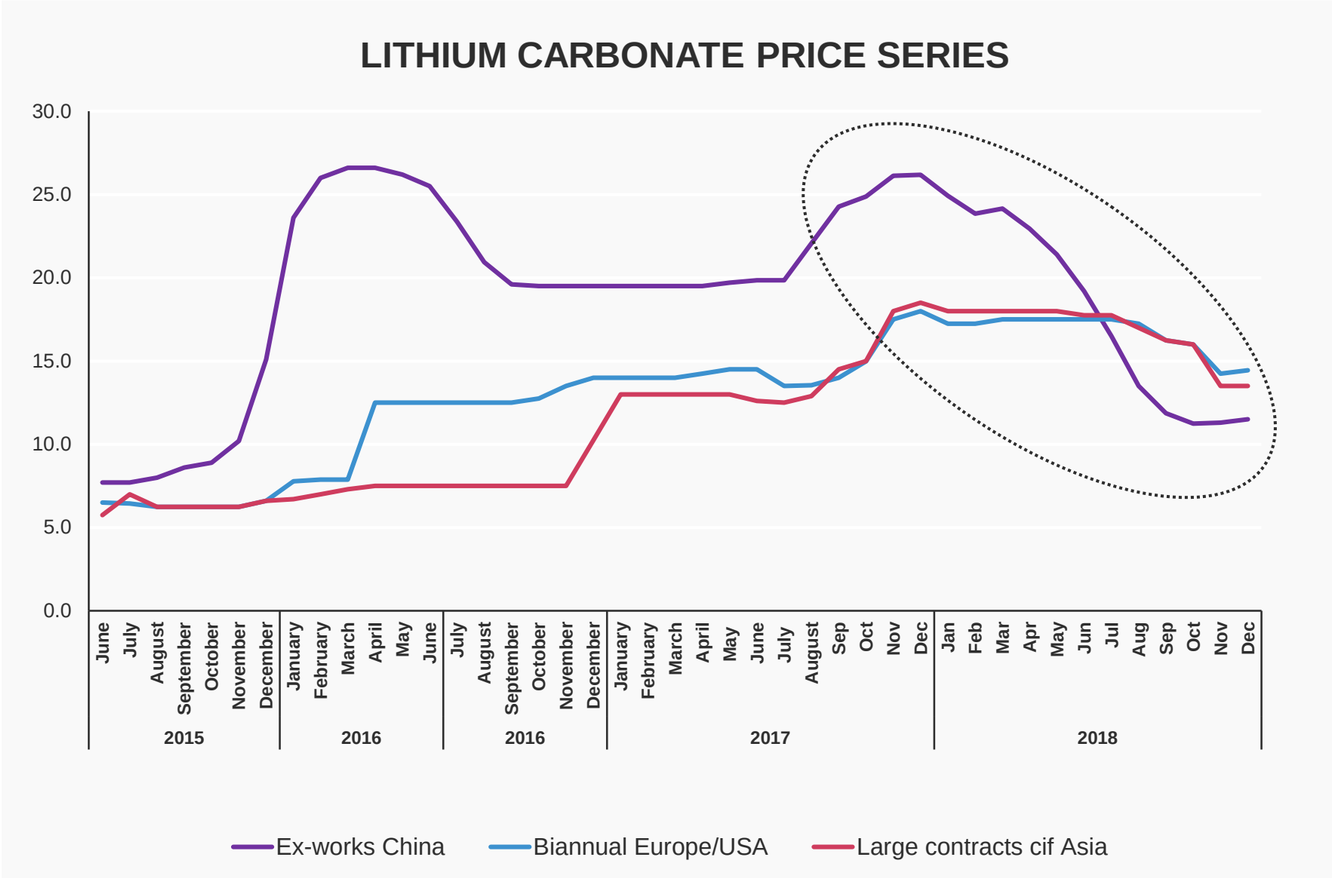
Prices indicated at 115,000 yuan

Prices indicated between 108,000-115,000 yuan



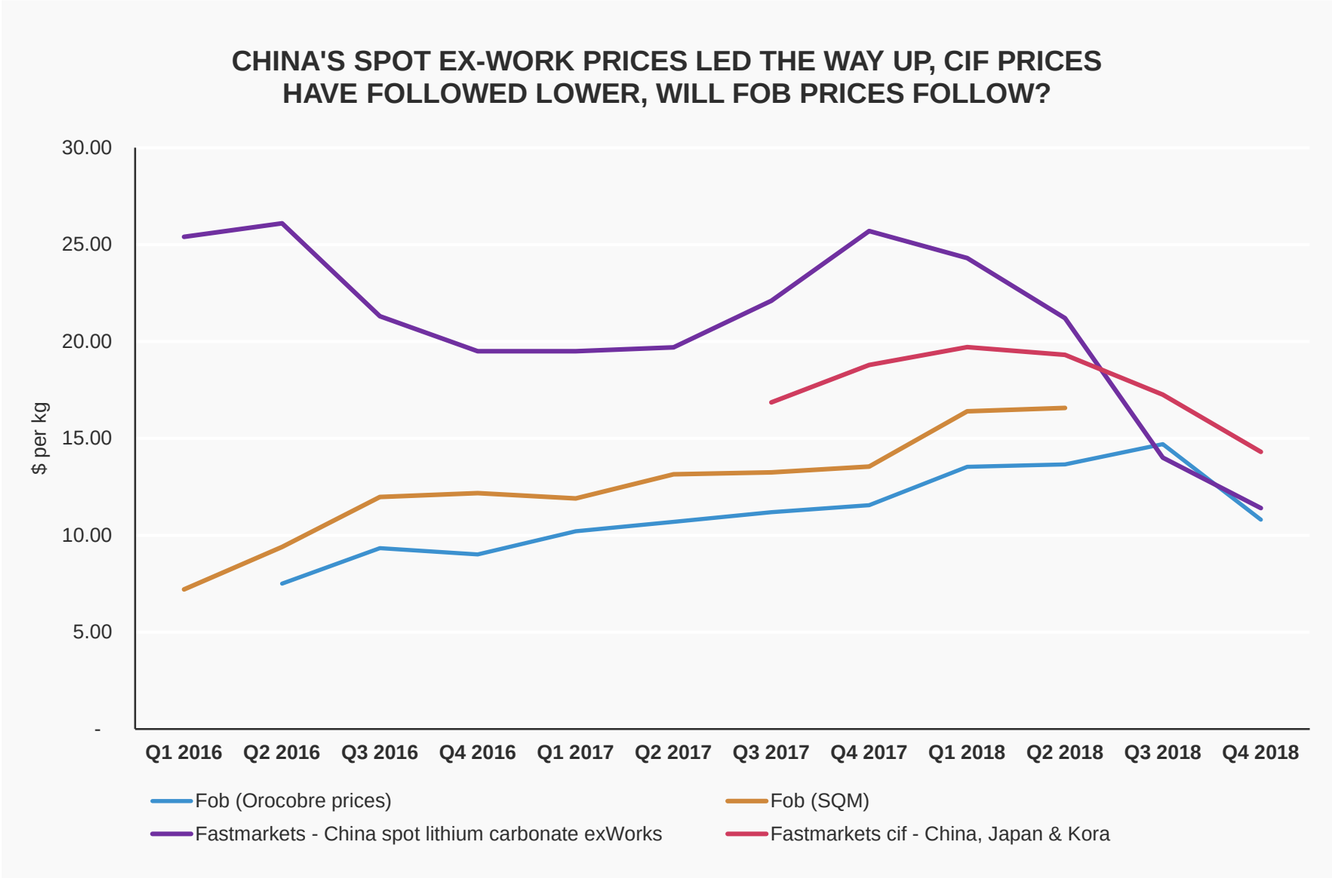
China spot Lithium prices lead the pack

- Traditionally producers set prices
- Spot market increasingly relevant as China becomes the main processing centre
- We see Chinese spot prices as leading other Lithium prices – on the way up and on the way down. As such, we see this as the most influential of prices
- Key will be whether the traditional South American price setters and their fob prices, now follow China ex-works spot prices lower



Will fob South America Lithium prices follow China spot prices lower?

- Those following producer prices tend to discard spot prices as an irrelevance – we think that may be wishful thinking
- Orocobre's price fell in Q4'18 to $10,587 per tonne from $14,699 in Q3. (Grade issues and soft market conditions in China)
- As the Lithium market grows to meet the challenges of the huge new market spurred by the EV & ESS era, a more dynamic and transparent pricing system will be demanded by multi-national downstream OEMs
- A benchmark spot price and exchange prices will become the norm



Price evolution

1-to-1 price negotiations are time-consuming. Benchmark or exchange prices can simplify the process and cut overheads.	Benchmark prices are also impartial.	And, adopting a benchmark does not mean one price for all.	Much talk about chemicals, not commodity.	But, quality and impurities can be adjusted for by a premium or discount to the benchmark price.	Likewise quantity and location differences can all be adjusted for by the same means.

BENCHMARK **+/–** **PREMIUM/DISCOUNT** **=** **YOUR PRICE**

Producer prices → PRA prices → Exchange prices

Advantage of an exchange price

- Focal point for pricing – so provides liquidity and transparency
- Provides platform for risk management
- You can price independently from your supplier / customer.
  - You agree a premium/discount to the benchmark price depending on tonnage, timing, location and grade etc and agree to buy/sell basis an unknown average of period in the future
  - You are then free to fix the benchmark price as and when you get orders, which can then be priced at the current market price.

How?

FOR EXAMPLE:

You agree to buy physical material basis the unknown average of say When you want to fix the price you buy a futures contract at say $17/kg and sell same amount basis the average of Q3’19 (unknown). The seller can likewise fix their selling price at time/price that suits them.

Cobalt price volatile – another spike

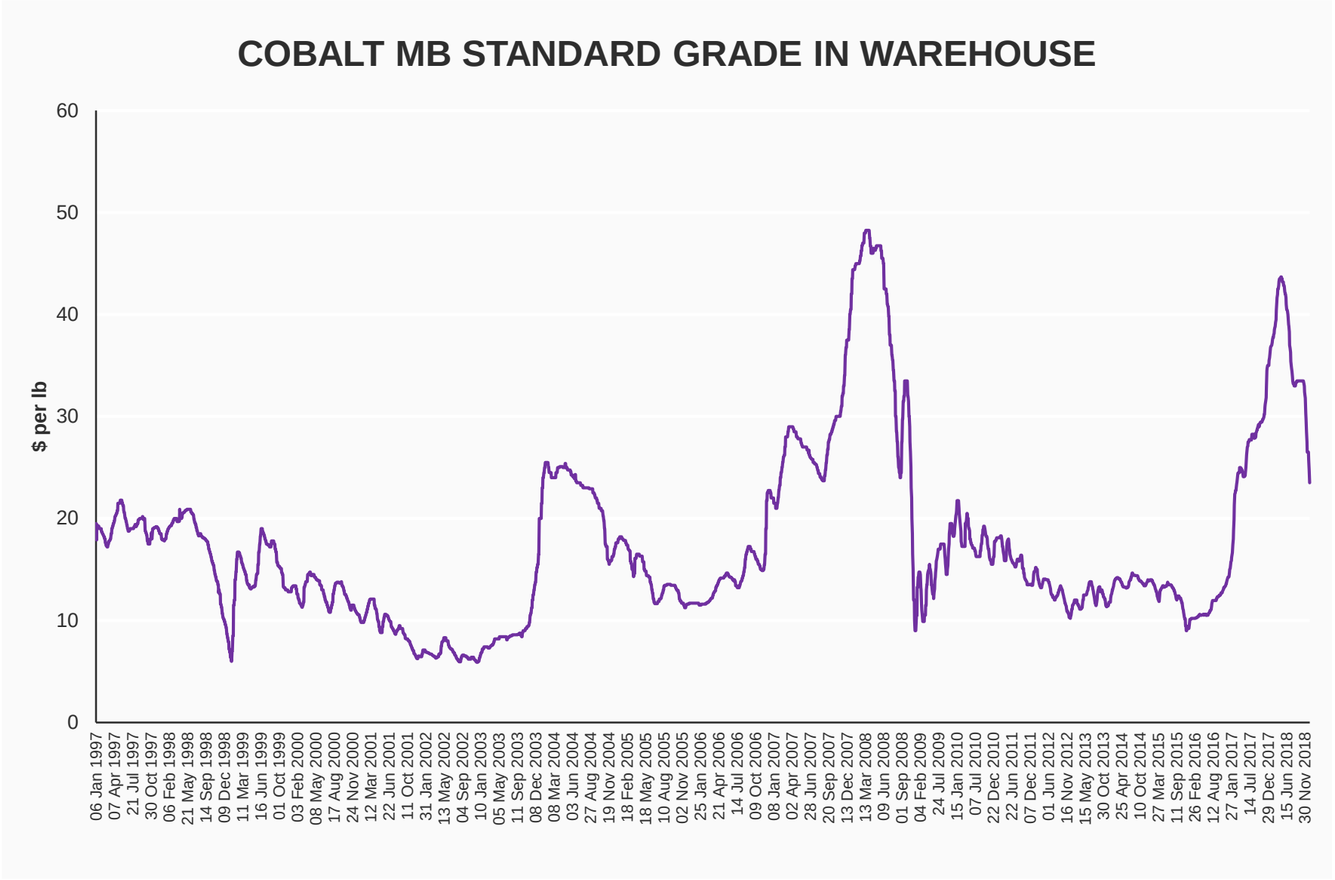
2007-2008 spike – Consumer electronics + supply disruptions in the DRC.

Followed by the down draft from the demand collapse after the Great Financial Crisis

Then up again in late 2016 as China grasped the EV story with both hands.

But another supply response has brought with it a reality check…

…but, the market faces a demand shift unlike anything it has seen before.



Vanadium – price spikes driven by ferrovanadium

Vanadium pentoxide and ferrovanadium Fastmarkets MB benchmarks

90% vanadium is used in ferrovanadium

Chinese requirements for higher quality steel rebar has largely driven demand

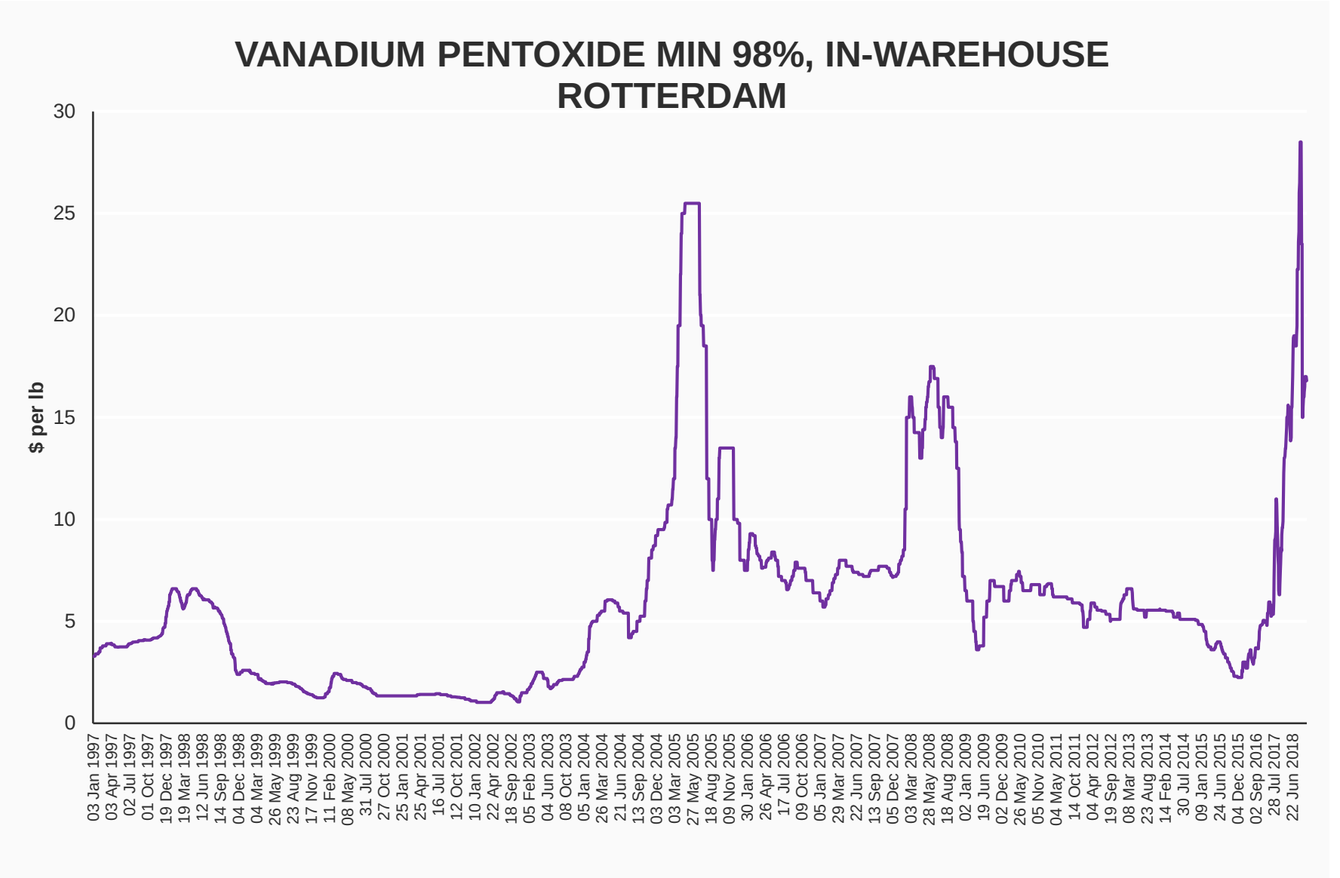
Some substitution recently from ferro-niobium in response to ferrovanadium price spikes

Prior low driven by over production in China leading to reduction in capacity around the world

Recent environmental shut downs as well as demand rises in China then led to shortage and latest price spike

Supply response from Russia, South Africa, Brazil

Battery demand not impacting market fundamentals to drive price

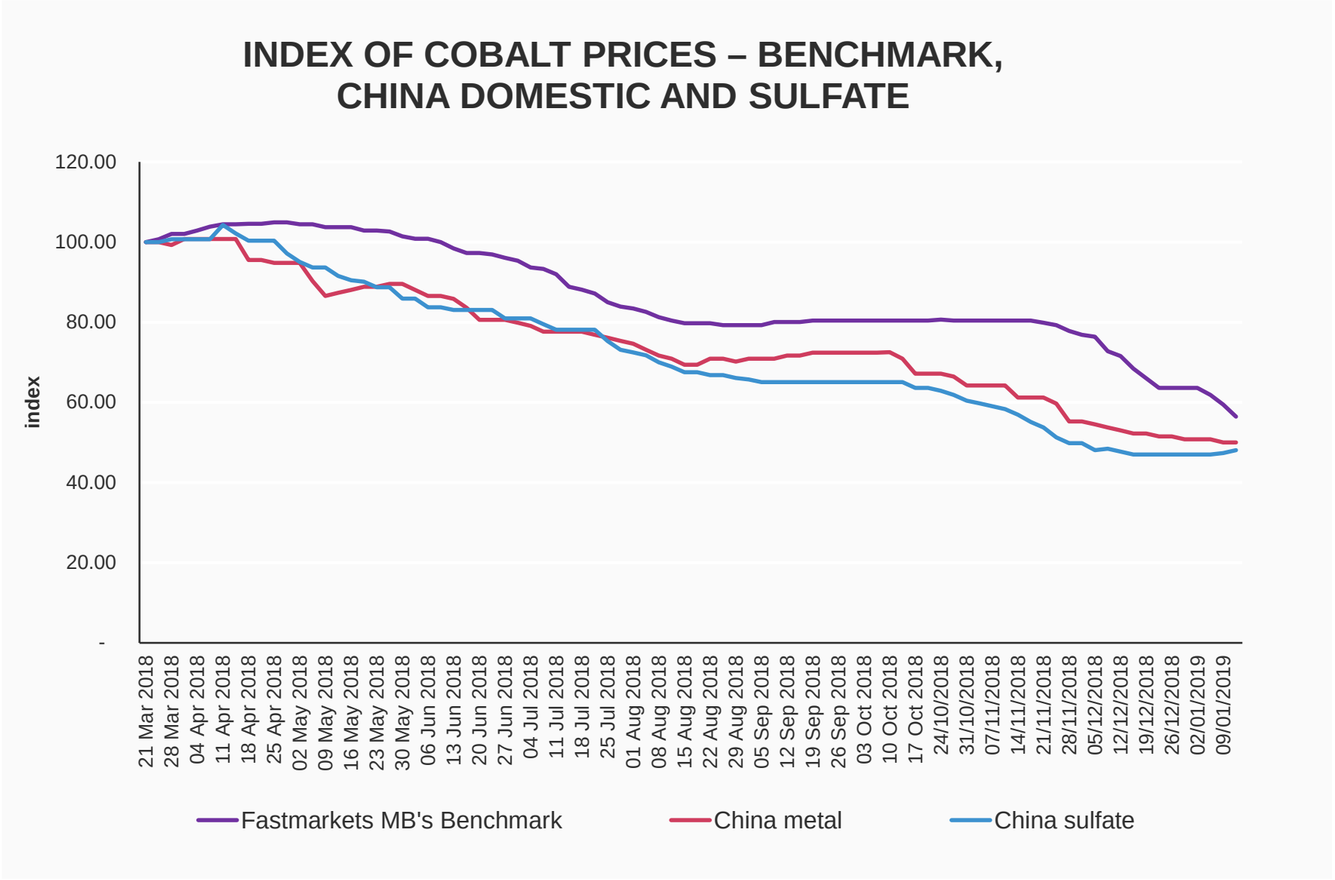


Cobalt price series follow China market lower

For now the ramp-up of two large producers in a short space of time has created an oversupply situation.

Like Lithium, the surplus shows up in China as it is the processing and converting heart of the battery raw material world.

The domestic Chinese price has led the way on the downside, but prices are now converging.



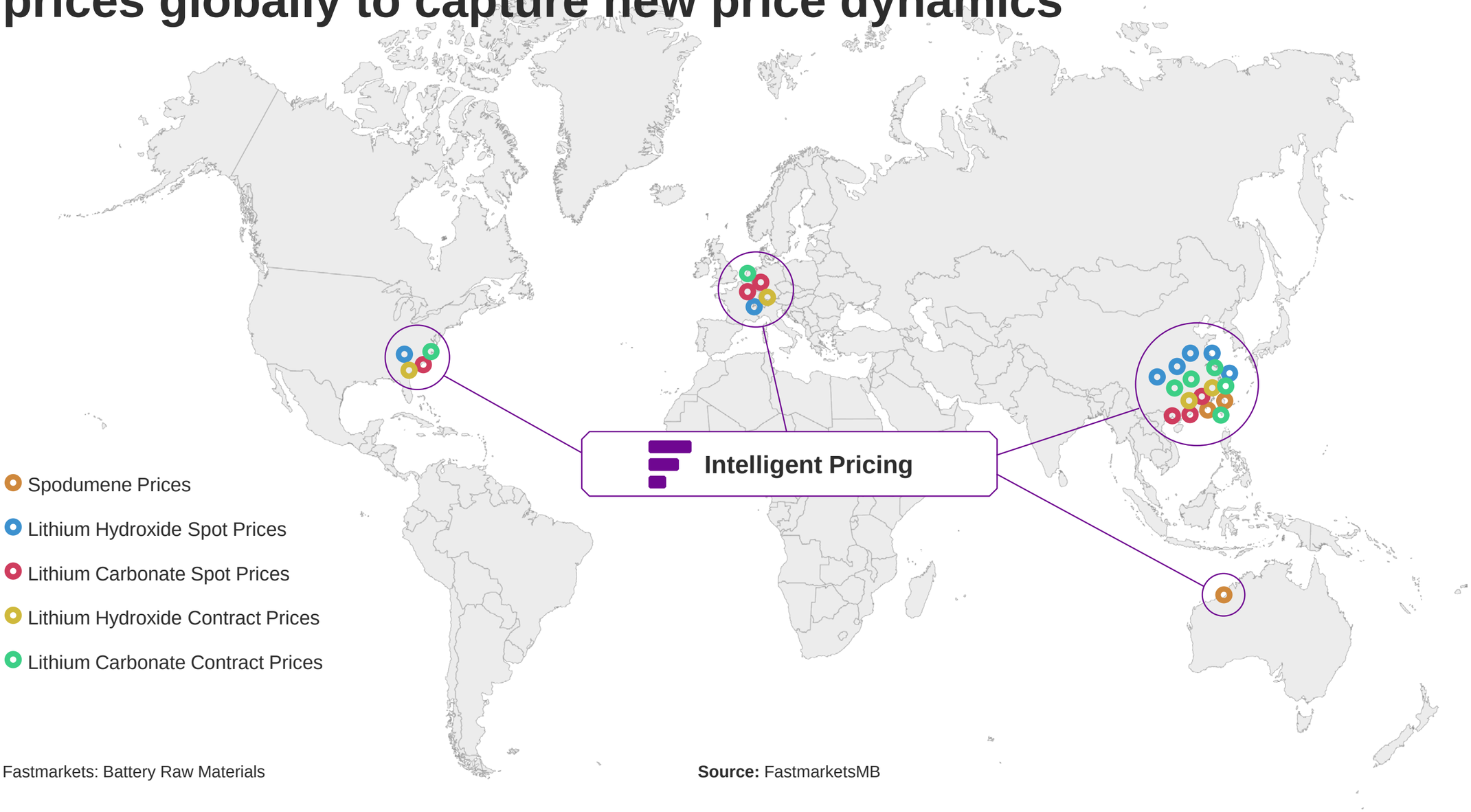
Our focus on the battery raw materials market

The outlook

Price forecasts and models: Fastmarkets has data models for

- **Supply, including current producer capacity and planned projects**
- **Demand, by battery factory capacity and end use markets, particularly EVs**
- **Price outlook for world pricing**

Fastmarkets monitors 30 different Lithium prices globally to capture new price dynamics



Source: FastmarketsMB

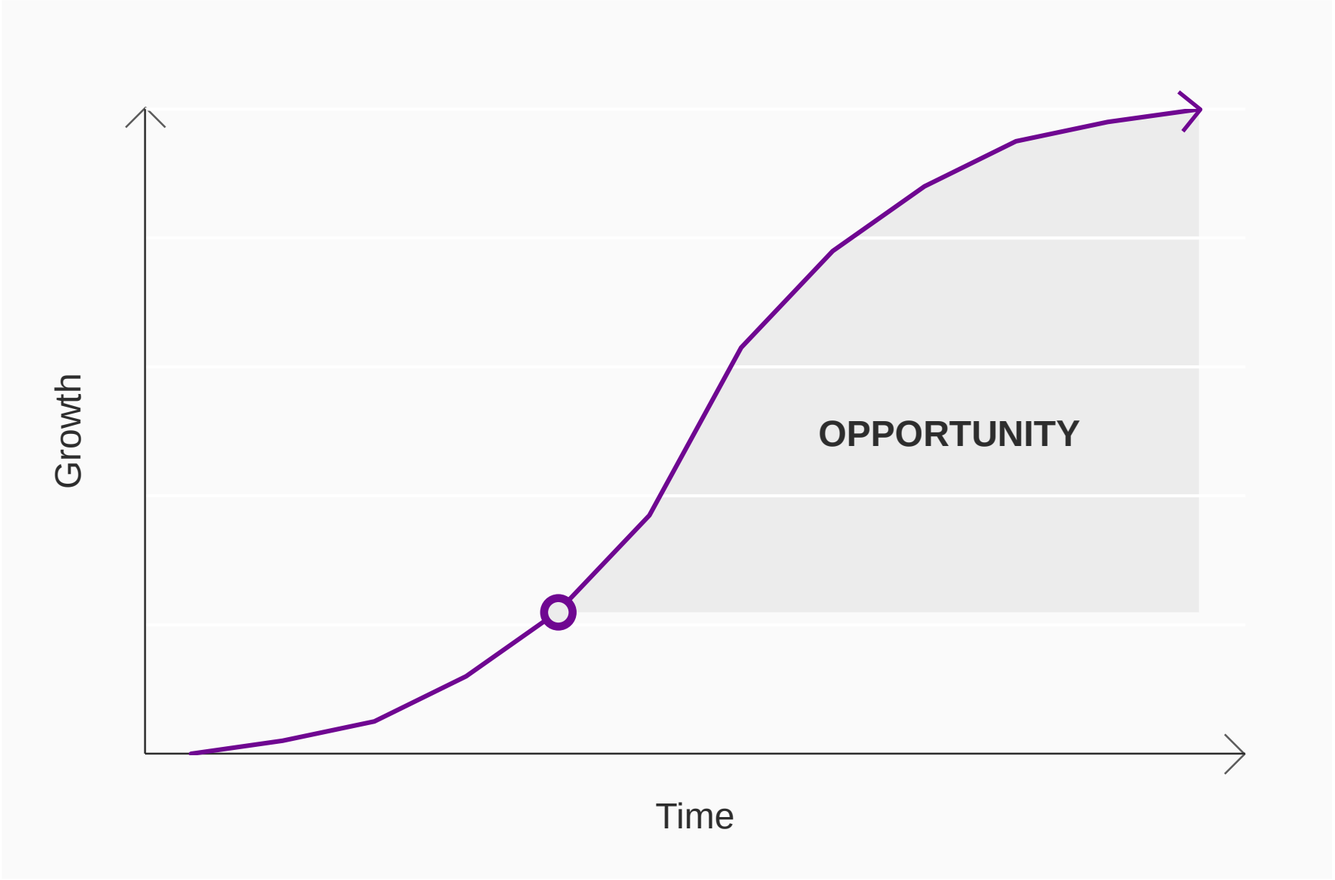
Outlook for battery raw materials

Judging by price weakness in Lithium, Cobalt and Nickel, you could be forgiven for being concerned about the outlook …

…but that would be a mistake.

The outlook is second-to-none –
EVs & ESS are in the early stages
of a new technology S-curve.

All we are seeing, is the usual boom/bust cycle of an emerging market.



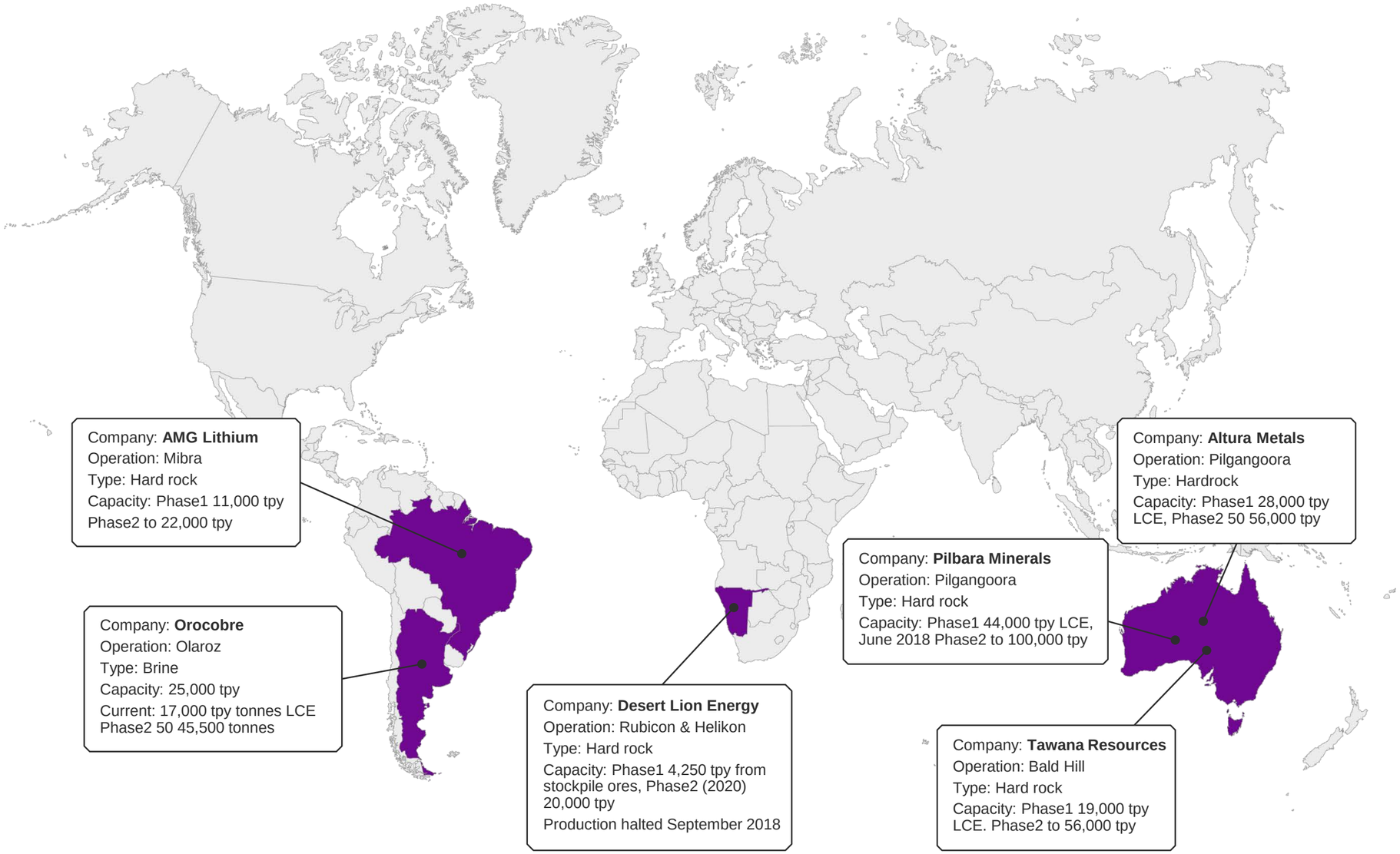
Supply responses – impressive

The price boom – not surprisingly prompted a supply response.

In Lithium the ramp-up of 4-5 new hard rock operations in a short pace of time not surprisingly created oversupply.

The start up of two large operations in DRC is having the same effect in Cobalt.

Both these supply responses have coincided with a pick-up in China's processing capacity and knowhow.



More supply to come on stream in 2020 but lower prices will delay some projects

Projects	Company	Location	Type	Financed	Permits	DFS	Offtake	Start	Initial production LCE
Quebec	**North American Lithium**	Canada	Spodumene		√	√		2018	23,000
Wodgina	**Mineral Resources**	Australia	Spodumene	√	√	√		Oct'18-Mar'19	45,000
Whabouchi	**Nemaska**	Quebec	Hard rock	√	√	√	90%	2020/21	34,000
Cauchari-Olaroz (1)	**LAC/ SQM**	Argentina	Brine	√	√	√	√	2020/21	25,000
Sonora	**Bacanora Minerals**	Mexico	Clay	partly	√	√	√	Q1 2020	17,500
Rincon	**Argosy Minerals**	Argentina	Brine						Pilot 500, then 1,500
Lithium Thacker Pass	**LAC**	USA	Clay						30,000
Sal de Vida	**Galaxy**	Argentina	Brine	√		√	√		25,000
Arcadia Lithium	**Prospect Resources**	Zimbabwe	Hard rock						26,000
Centinario	**ERAMET**	Argentina	Brine						20,000
Mt Holland/Earl Grey	**Kidman/SQM**	Australia	Spodumene				√		40,000
Kwinana refinery	**Kidman/SQM**	Australia	LIC/LiH					2020	40,000
3Q	**Neo Lithium**	Argentina	Brine					2021/22	35,000

Cobalt projects ramping-up and next in line

Cobalt projects - ramping-up, restarts and new operations							
Company	Mine	Country	Capacity	Expected start	2018	2019	2020
Glencore	Katanga	DRC	34,000	2018	8,000	20,000	34,000
ERG	Metakkol RTR	DRC	15,000	2018	2,000	10,000	14,000
Chemaf SPRL (Shalina Resources)	Etoile	DRC	6,200	2018	5,200	7,000	7,000
Metal Mines SPRL (Hanrui)	P (unknown)	DRC	5,000	2018	4,500	6,500	9,000
LA SINO-CONGOLAISE DES MINES	Sicomines	DRC	3,000	2018	770	1,900	2,000
Sheng Tun Mining Group	CCM/CCR (collecting ores)	DRC	3,500	2018	500	2,000	3,000
Independence Group	Nova mine	Australia	800	2017	740	740	740
Zijin Mining	Kamoa/Kolwezi	DRC	10,000	2019		500	1,000
George Forrest International SA/GTL	Big Hill (Lubumbashi)	DRC	5,500	2019		1,500	3,000
Pengxin Resources	PE1078	DRC	3,000	2019		1,500	2,800
Congo International Mining Corporation	Luisha	DRC	1,400	2019		300	300
Congo International Mining Corporation	MKM	DRC	1,000	2019		300	300
Panoramic Resources Ltd,	Savannah mine	Australia	800	2019		300	300
Tengyuan Cobalt	collecting ores	DRC	3,000	2019		1,000	2,000
Chemaf SPRL (Shalina Resources)	Mutoshi	DRC	16,000	2020			1,000
Congo Silver Age	PR12337	DRC	3,000	2020			500
Tianjin Maolian Technology (Tailings operation)	Near Kitwe City	Zambia	3,000	2020			2,020
Wanbao Mining	Pumpi-Kamasani	DRC	5,000	2020			500
Autralian Mines Ltd	Sconi	Australia	2,000	2020			1,000
China NF Metals Industry	Deziwa	DRC	10,000	2020			3,000
eCobalt	Idaho Cobalt Project	USA	1,500	2020			-
CleanTeQ	Sunrise	Australia	4,400	2021			-
Fortune Minerals	NICO Mine	Canada	2,000	2022			-
RNC	Dumont	Canada	1,000				-
Nzuri	Kalongwe	DRC	1,500				-

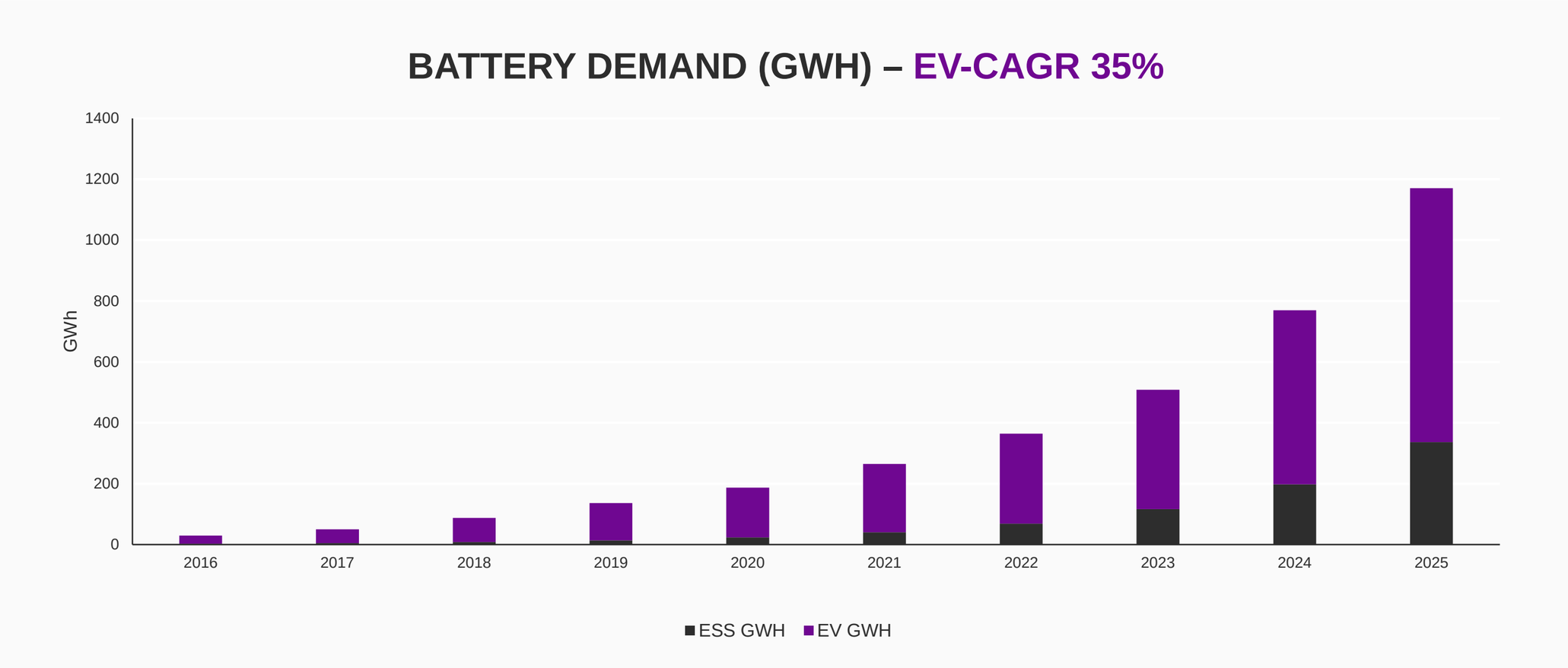
Source: Fastmarkets

N.B. - We do not expect all these to start in a timely fashion – low prices are likely to disrupt new production and expansions

No supply shortage any time soon…
…but that will then change.

Strong compound average growth rates (CAGR) year-after-year will create a significant challenge for producers.

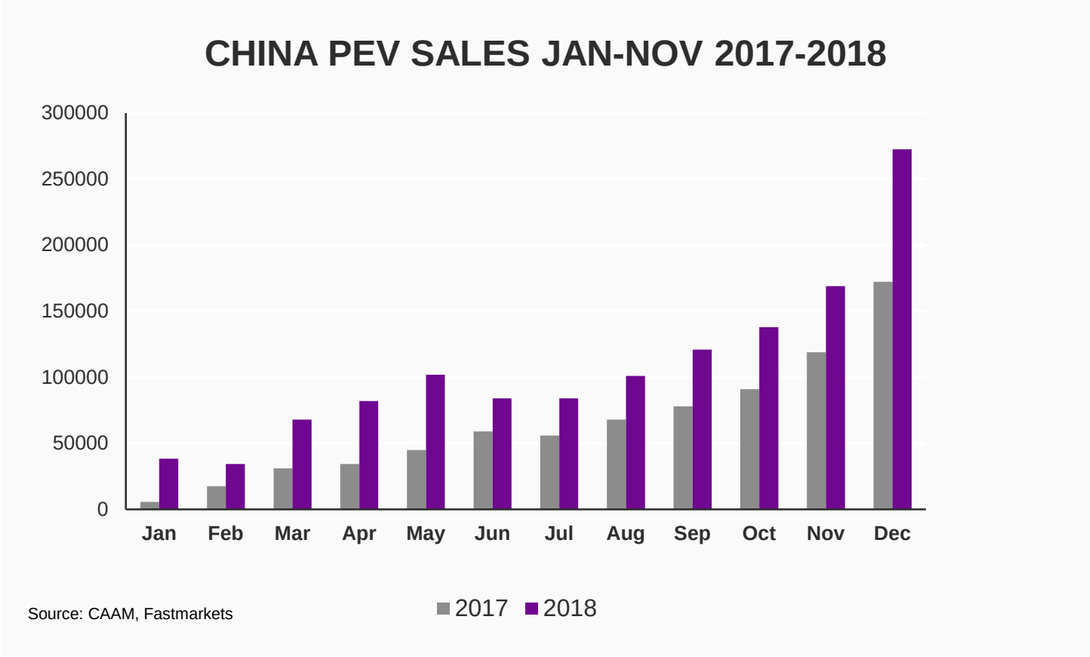
Outlook for battery raw materials

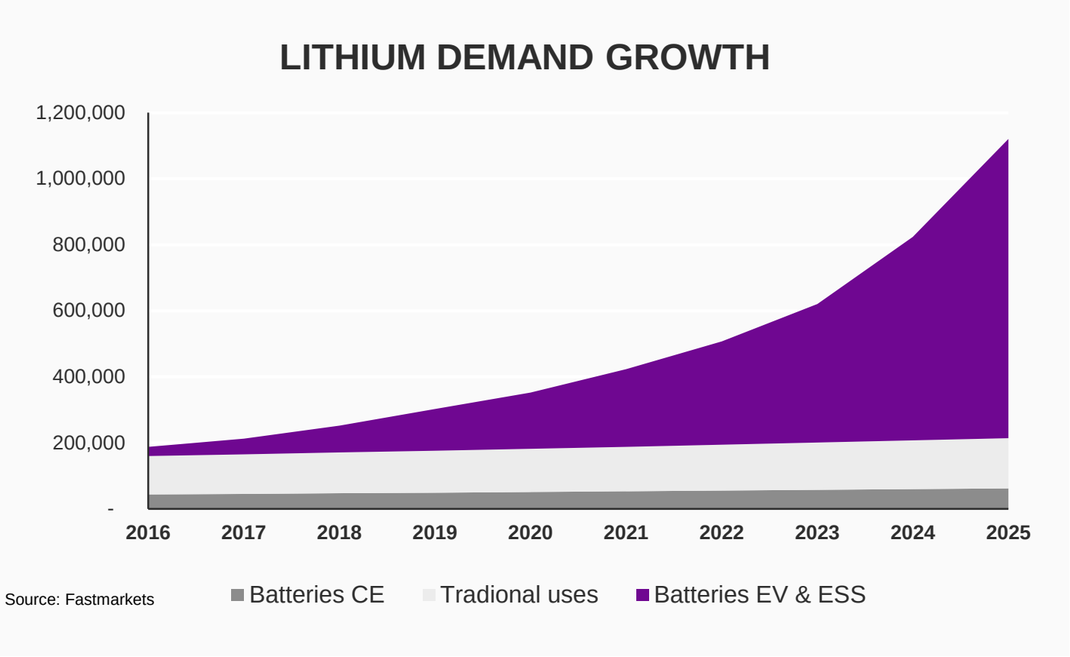


Fastmarkets: Battery Raw Materials

Source: Fastmarkets

China’s EVs sales rebound





Source: CAAM, Fastmarkets

EV sales will multiply seven-fold by 2025 to underpin demand for Lithium

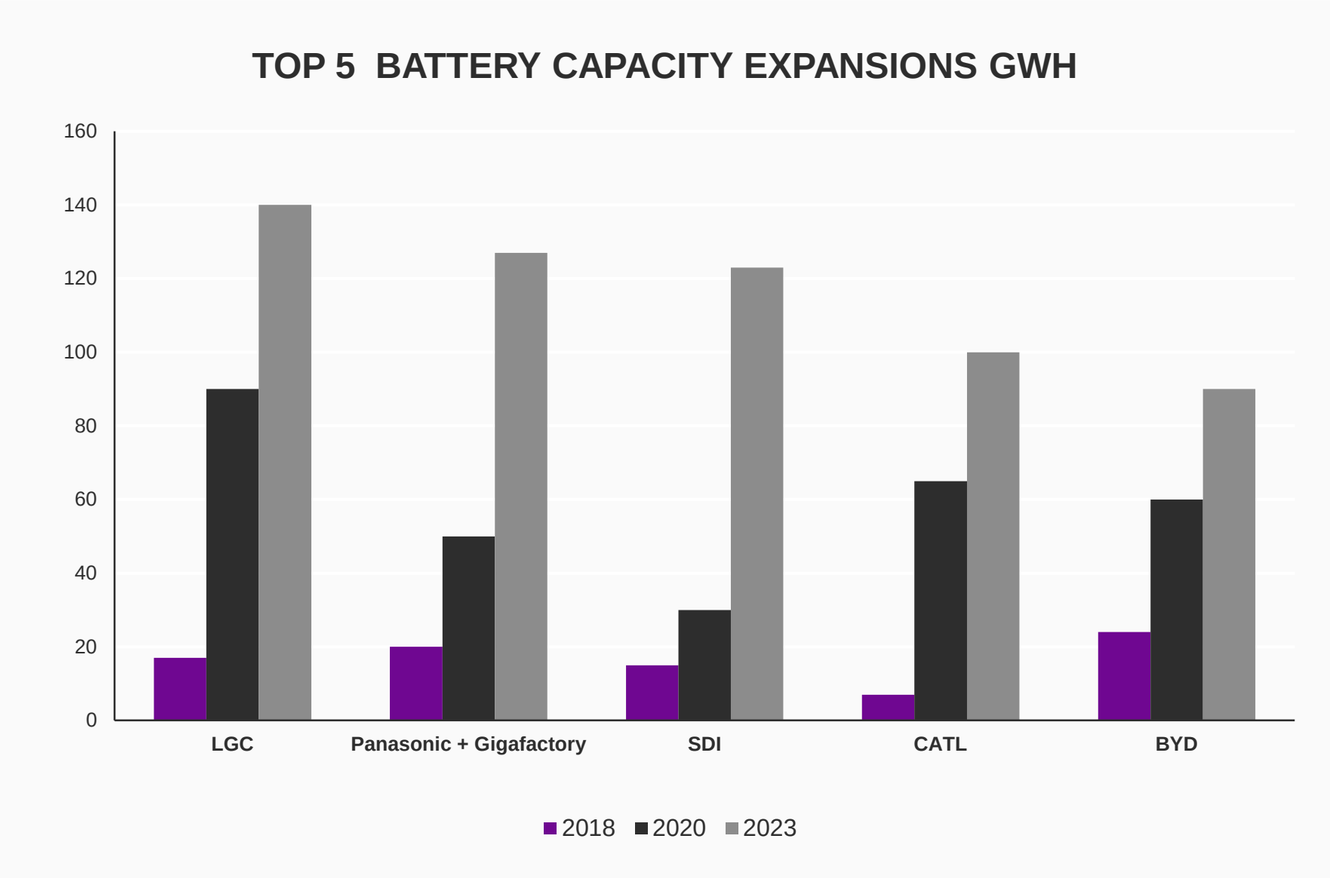
- Fastmarkets' base case expects 17m EVs by 2025
- Three key drivers of demand for battery raw materials:
  - EVs – rising strongly - 62% in 2018 in China & 35% in EU , with US sales up 81%, (given Model 3)
  - ESS – from a low base are expected to grow at a faster pace than EV – although not all will be Lithium-ion, or NCM
  - Traditional uses – ceramics, glass, greases and medical – CAGR 3-4%

	EV sales (m)	EV market share %
2016	0.8	0.9%
2017	1.3	1.4%
2018	2.2	2.3%
2020	4.3	4.3%
2025	15-18	13-17%

Source: Fastmarkets

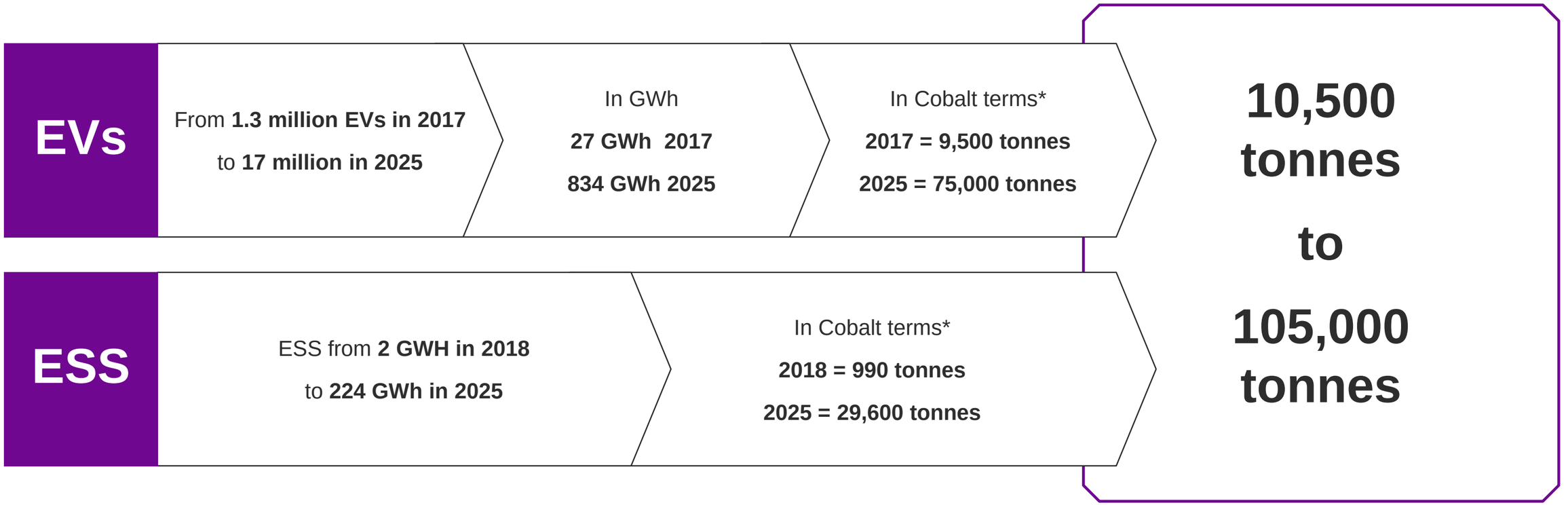
Battery factories – springing up everywhere

- EV battery factories plan rapid growth
- 10-fold increase among Top 5 (56 GWh in 2017 to 580 GWh in 2023)
- Added capacity also from new entries such as Northvolt & TerraE amongst many others
- New capacity expansion plans are being announced regularly – almost weekly
- Expect adequate battery supply, especially as energy density increases too
- We see no shortage of battery capacity – if anything China's habit of creating excess capacity could well feature again, at least over the 2021-2025 period. They maybe challenged after that



Source: Fastmarkets

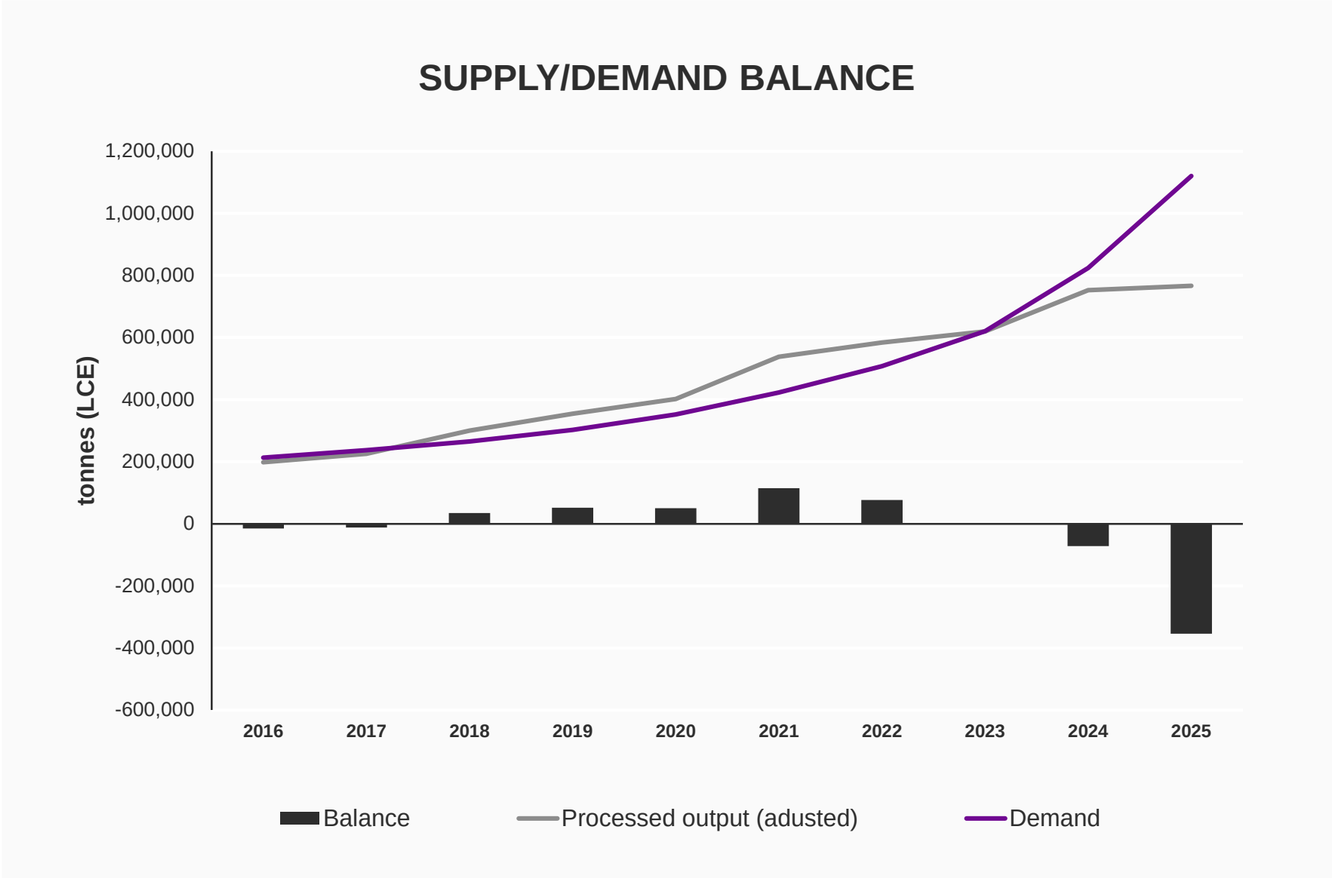
Cobalt outlook – so what lies ahead?



* Taking into account that not all LIB will contain Cobalt

Lithium outlook

- The demand surge was followed by the supply response
- Spot prices have fallen 54%, since peaking in November 2017
- Market now expected to remain in surplus until 2022
- But demand fundamentals remain exceptionally strong
- Supply will ultimately not be able to keep up – pushing the market back to a deficit
- The next wave of supply to come on stream will be in 2020
- Between now & 2021 we expect demand to ”catch up” and then to accelerate from 2023 as EVs become mainstream

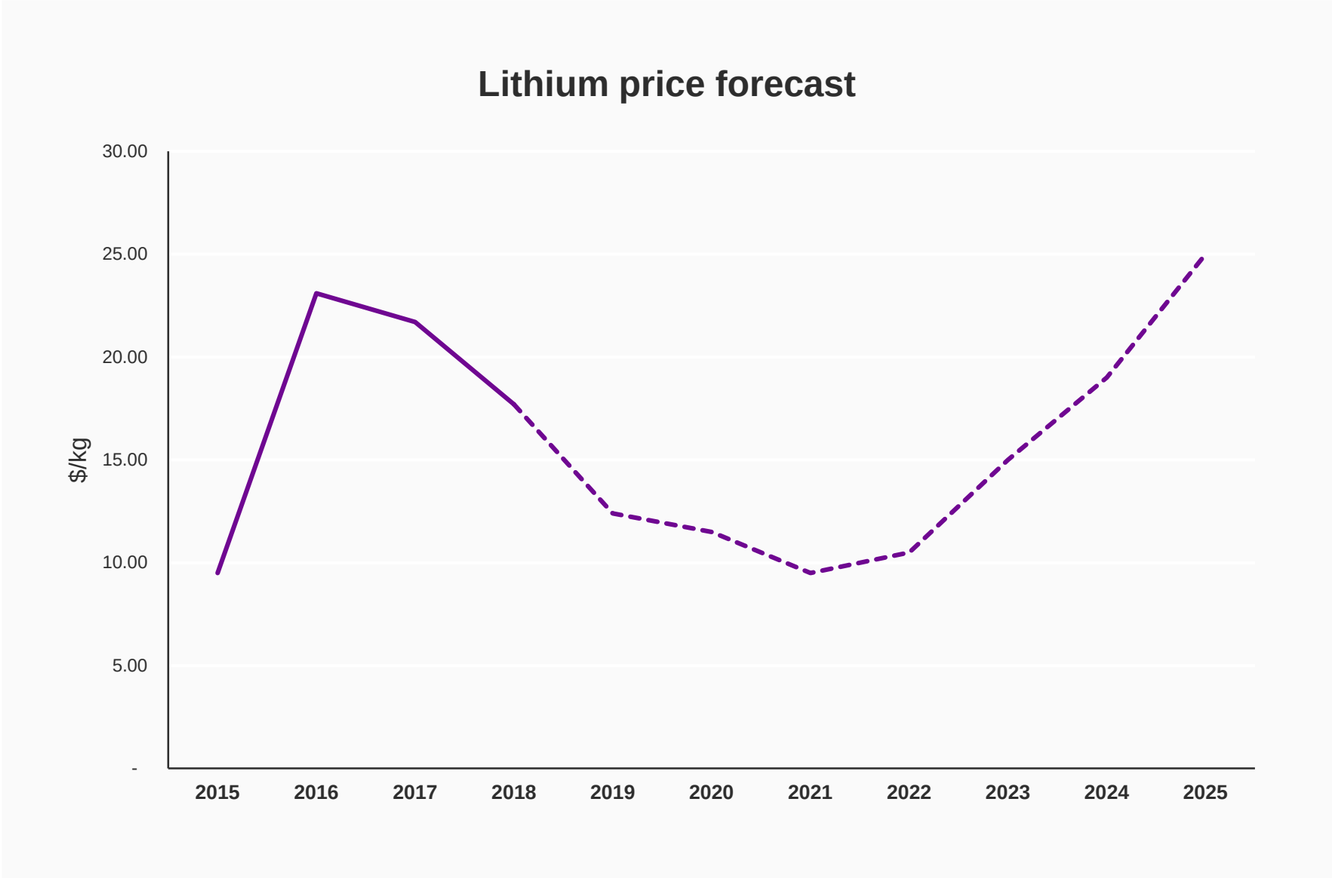


Source: Fastmarkets

Price forecasts Lithium & Cobalt

SUMMARY

Bullish long term, but further price weakness over the next few years



Source: Fastmarkets

The biggest risk is the market underestimating the magnitude of what lies ahead

1. We expect the Lithium-ion battery to dominate the rechargeable battery space for at least the next ten years, and probably longer
2. We are in the dip of the roller coaster ride now, but the rise out of the dip will blow all expectations
3. EVs only have c2% of an industry that ships c100m vehicles per year – this will change rapidly
4. On top of that there is equally bullish outlook for energy storage systems
5. Be warned – the consensus for demand growth runs the risk of truly underestimating actual demand

Our focus on the battery raw materials market

Tightness in raw materials

Appendix – acronyms

LGC

LG Chemical Ltd
Lithium ion battery manufacturer

SDI

Samsung SDI
Lithium ion battery manufacturer

CATL

Contemporary Amperex Technology
Chinese Lithium-ion battery manufacturer

BYD

BYD Auto Ltd is a Chinese car manufacturer

The following are Lithium-ion battery cathode materials that describe the type of battery

NCA	Nickel Cobalt Aluminium
NMC	Nickel Manganese Cobalt - a generic name of the battery type with the following detailing the proportion of each metal in the cathode
NMC 811	8 parts Nickel, 1 part Manganese and 1 part Cobalt
NMC 532	5 parts Nickel, 3 parts Manganese 2 parts Cobalt
LFP	Lithium iron phostate
LMO	Lithium manganese oxide
LCO	Lithium Cobalt oxide