The Lithium Price Reversion Risk

A look at long term lithium supply, demand, and incentive prices

Ben Atkinson | July 2023

"Show me the incentive, and I will show you the outcome."
– Charlie Munger

Overview

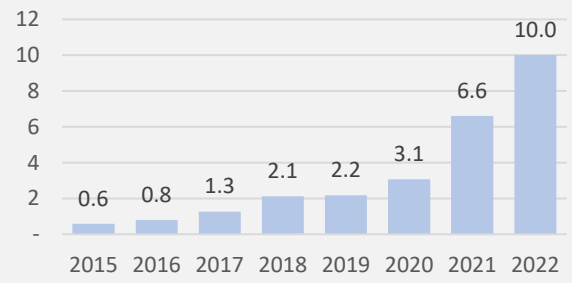
Lithium prices are currently well above incentive prices, which has catalysed a supply response with material increases in global production being developed in the coming years. Lithium reserves are abundant around the world and the cost curve is relatively flat, with multiple mining methods and regions comfortably economic even at much lower lithium prices. Owing to these factors, it is likely that lithium prices will eventually fall significantly, along with increased supply.

In this note, we discuss the demand & supply equation, current and incentive lithium prices, and the price assumptions implied by the market's current valuation of the large ASX lithium companies. We view the market as extrapolating unsustainably high lithium prices and margins, such that these companies are exposed to considerable valuation risk.

Lithium Demand

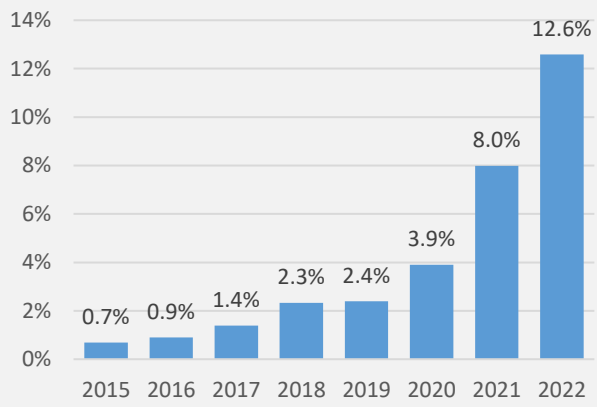
The key driver of the structural growth in lithium production is the demand for electric vehicles (EVs). EV sales reached 10m vehicles in 2022, representing 13% of all global vehicle sales.

Figure 1: Global EV sales (#m)



Sources: IEA, OICA, worldometers

Figure 2: Global EV as a % of overall vehicle sales



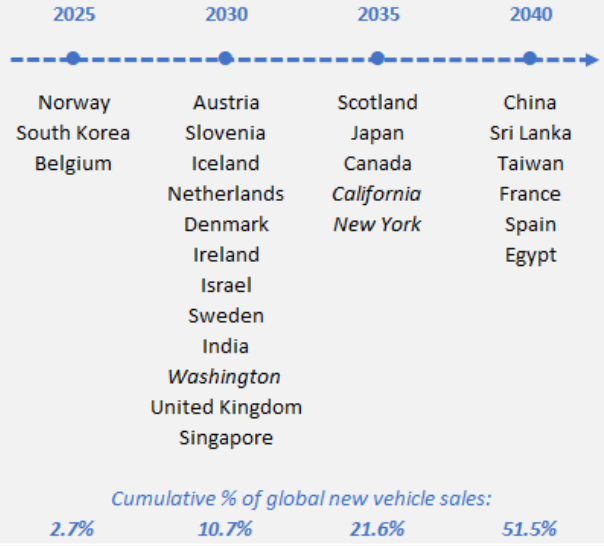
Sources: IEA, OICA, worldometers

Despite recent growth, reaching high levels of EV penetration in the mass market may prove challenging. A significant portion of early EV adopters have effectively purchased luxury vehicles. In the U.S., the top 10 selling EVs are on average twice the price of the top 10 selling ICE vehicles, with the latter selling 10x as many units.

As the bulk of the market by volume is concentrated in affordable, mass-market cars, not luxury EVs, consumers may have to accept lower range EVs, with smaller batteries to reduce cost (and lithium content), in this segment of the market.

At the current run rate of 4% incremental gain in penetration annually, EV sales will reach a 45% share of new vehicle sales by 2030. This will require consumers exhibit a strong voluntary preference for EV purchases, ahead of national plans to phase out ICE vehicles (per the figure below, countries with ICE vehicles bans by 2030 total only 11% of new vehicle sales globally).

Figure 3: ICE ban by country and year



Source: Inside EVs

Global vehicle sales have been in a stable range of 85-90m vehicles per year. Pre-Covid, there was a very slight decline trend in the new cars sold per capita figure, and Covid further accelerated the decline from ~12 to 10 new vehicles per 1,000 people.

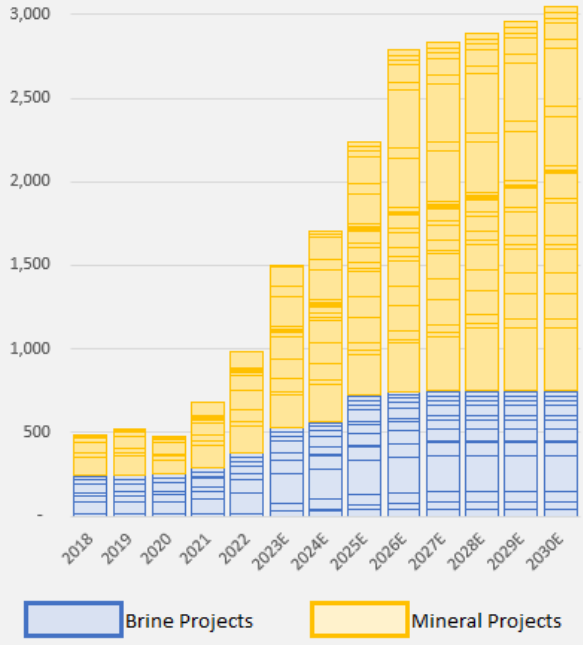
Notwithstanding the potential for structural changes to the rate of vehicle ownership (such as increased ride sharing, autonomous driving, and increased work-from-home dynamics), a 45% EV share of 90m vehicles suggests around 40m EVs sold in 2030, equating to 4x more EVs sold than in 2022.

There is a wide range of electric motor capacities, and therefore lithium content, but today the average is about 50-70kg of LCE per vehicle. Using the top end of that range and adding in the non-EV lithium demand results in total demand of ~2.6mt LCE in 2030.

Lithium Supply

Lithium deposits are abundant around the world, and with market prices currently well above incentive prices, there is considerably more supply coming to market. Based on the committed and potential expansions of only 40 of the largest announced brownfield and greenfield projects, production capacity could as much as triple by the end of the decade, from 0.9Mtpa to ~3.0Mtpa LCE.

Figure 4: Global lithium supply potential – 40 of the largest announced projects (ktpa LCE)



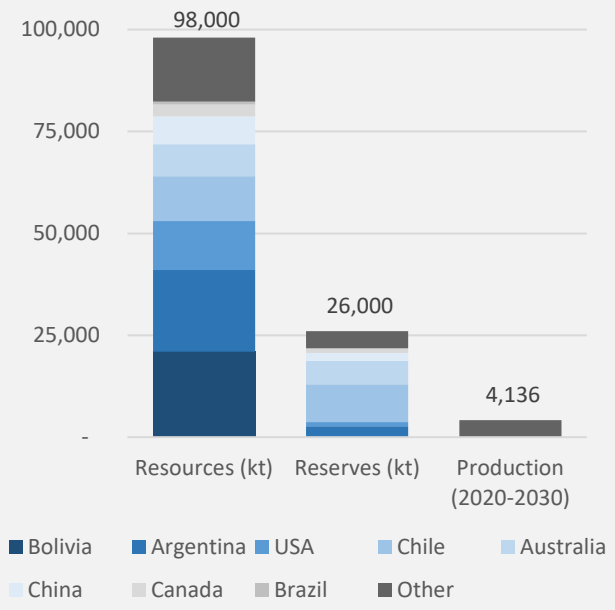
Sources: IGO, Allkem, Pilbara Minerals, SQM, Albemarle, Livent, RIO, Argosy, BYD, Tianqi, Lithium Americas, Gangfeng, JEMSE, Western Minerals, CITIC Guon, Lepidico

Notably this excludes: lepidolite projects beyond Yichun, clay projects, mines and regions that are still in feasibility stage, any uplift from Direct Lithium Extraction (DLE) development (which could increase brine recoveries from <50% to >90%, effectively doubling brine production), lithium or EV battery recycling, and production from Bolivia (the location of the world's largest lithium resource).

The world's lithium reserves are abundant, with grade variation relatively low, rendering mining economic in most regions. Current production is dominated by Australia, Chile, and China, with several large deposit regions such as Bolivia, USA and Canada yet to establish material production.

Current reserves (26,000kt of contained lithium) covers 200 years of production at 2022 levels of production, and 43 years at our estimated 2030 levels of production. Global resources are 4x larger than reserves at almost 100Mt. Total cumulative production over the 2021-2030 decade will consume only 4% of resources globally.

Figure 5: World resources and reserves (kt contained Li)

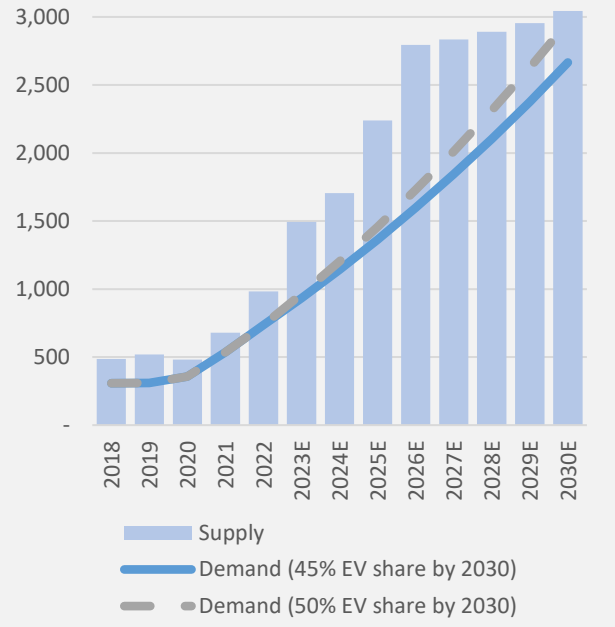


Sources: US Geological Survey 2022

Supply & Demand Equilibrium

Putting together the above assumptions sees a market that will move from near term deficit to medium term surplus, subject to new projects being brought to production on time. The additional potential supply sources mentioned will likely begin to move to development later in the decade, as existing expansion projects mature, and supply grows tight again.

Figure 6: Supply & Demand by year (kt LCE)



Sources: Supply per above charts on top 40 lithium companies' expansion, demand per OC estimates

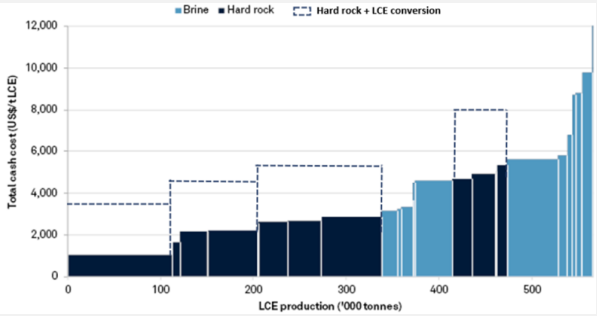
So why are lithium prices so high and behaving with such volatility?

As the Covid pandemic progressed into 2022, previously shuttered car production caused a global new vehicle shortage. At the same time, appetite for EVs grew, and China offered subsidies and consumer tax breaks in the EV market. The ramp up of lithium mining and processing was slow relative to the sudden spike in raw material inventory requirements for vehicle lead times. This was exacerbated by the limited amount of available spot volumes, as the majority of global production was locked up in offtake agreements. As supply and demand growth rates moderate, the surplus or deficit as a % of the overall market should reduce, resulting in moderated prices and less volatility going forward.

Production Cost Curve

Both hard rock and brine lithium products must be further processed into battery grade lithium carbonate or hydroxide. The lower concentration of spodumene requires considerably more processing. Cost curves will often depict the Lithium Carbonate Equivalent (LCE) cost, which ignores conversion losses and processing costs. Factoring in fixed conversion costs (US$2-3k/t LCE) and maintenance capex on conversion plants results in a much flatter cost curve than commonly depicted.

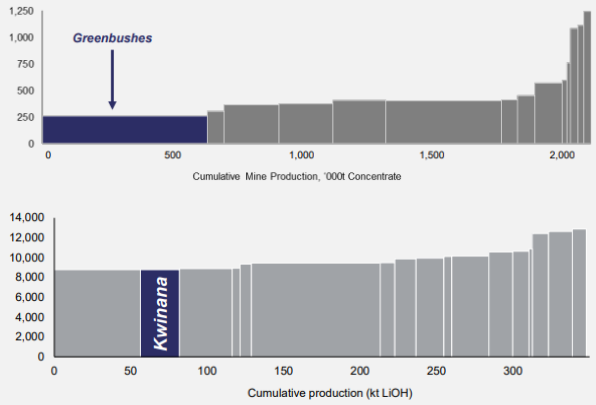
Figure 7: Lithium cost curve (to LCE with and without conversion costs)



Sources: S&P Global (2019), Optar conversion estimates

Outside of high-grade the Greenbushes mine (large WA asset at the bottom of the cost curve), the bulk of hard rock lithium mines around the world have similar grades and similar costs of production, resulting in a historically flat cost curve. Flat cost curves are also characteristic of the lithium hydroxide and lithium carbonate conversion facilities.

Figure 8: Spod and Lithium Hydroxide cost curves (US$/t)



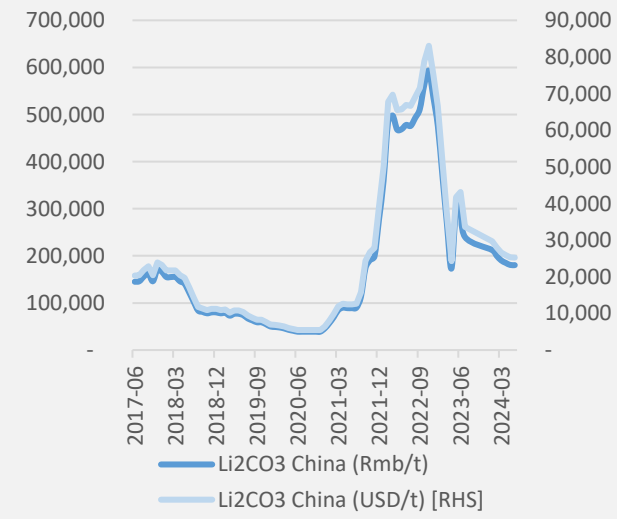
Sources: IGO TLEA presentation (2019)

Most prospective lithium projects pitched by western companies appear to claim unit cash costs in the bottom half of the cost curve. It is not unreasonable to expect most prospective projects to have similar costs, given their similar grades. These are typically well below current spot prices. The abundance of potential production sites with economic grades and costs will drive a supply response which likely to exert downwards pressure on lithium prices long term.

Market Prices & Incentive Prices

Market prices for lithium are highly opaque, with several pricing benchmarks reported by surveying players in the supply chain. While producers are increasingly shifting contracts to trailing benchmark reference pricing, most of the industry has operated through privately negotiated fixed price agreements, often with large, long-term offtake agreements.

Figure 9: Lithium Carbonate China price per tonne



Sources: Trading Economics, Guangzhou Futures Exchange (for prices beyond 2023-07)

Prices spiked in 2022 due to the rapid uptick in EV production but have begun to reduce considerably in 2023. Carbonate futures recently commenced trading on the Guangzhou Futures Exchange, with forward pricing over the next 6 months implying further declines of -40% to ~US$25k/t.

Even after the recent sell off, spot prices are still materially above incentive prices.

Spodumene

The spodumene concentrate price has fallen from a peak of US$8,000/t in 2022 to US$3,300/t spot (July 2023). This compares to an incentive price of US$500-600/t for Australian and Canadian spodumene production. Chinese lepidolite requires about 4x as much volume than spodumene to produce 1 tonne of carbonate or hydroxide, but Chinese capital costs are only about one-third vs Australian. The resulting lower-capital-higher-opex calculation results in a cost of carbonate production from lepidolite of ~US$10,000/t LCE, or approximately US$1,300/t spodumene concentrate equivalent.

Figure 10: Spodumene Economics & Incentive Price

Spodumene Economics (6.0% *Concentrate*)		Green bushes (IGO)	Pilgan goora (PLS)	James Bay (AKE)
Reserve Grade (Li_2O)	%	2.10%	1.18%	1.30%
Total Capital Costs	US$m	1,438	1,200	286
Production Capacity	kt	2,500	1,000	321
Unit Capital Costs	**US$/t**	**575**	**1,200**	**891**
Life of Mine	t	20	26	19
Incentive IRR (post-tax)	*%*	*8.0%*	*8.0%*	*8.0%*
Incentive Margin (post-tax)	US$/t	50	95	75
Tax Rate	*%*	*30%*	*30%*	*27%*
Incentive Margin (pre-tax)	US$/t	71	136	102
Unit Operating Cash Cost	US$/t	200	425	333
Other Cash Costs	US$/t	65	80	73
Maintenance Capex	US$/t	20	30	30
AISC	US$/t	285	535	436
Incentive Price	**US$/t**	**356**	**670**	**538**
Cash Margin	*%*	*20.1%*	*20.2%*	*19.0%*
Spod cost x Conversion	7.0x	2,492	4,692	3,768
Fixed Conversion Costs	US$/t	2,500	2,500	1,500
Incentive Price - LiOH	**US$/t**	**5,348**	**7,862**	**5,806**

Sources: IGO, PLS, AKE, CRU Group, Reuters

Spot prices over the last year have been 3-8x the incentive price of even the most expensive marginal producer. Prior to the recent price boom, the spodumene price averaged ~US$800/t, in line with the 90th percentile on the cost curve.

Lithium Carbonate

The lithium carbonate price has fallen from a peak of US$80,000/t in 2022 to US$35,000/t spot (July 2023). This compares to an incentive price of ~US$6,000-6,500/t for South American and Chinese brine lithium carbonate production.

In contrast to hard rock production, brine carbonate is characterised by higher capital costs but lower operating costs, with the resulting carbonate product being higher concentration and value than spodumene.

Figure 11: Lithium Carbonate Economics & Incentive Price

Lithium Carbonate Economics (99.5% Li2CO3)		Sal de Vida (AKE)	Olaroz (AKE)	Qinghai Lanke (China)
Total Capital Costs	US$m	794	425	433
Production Capacity (LC)	kt	45.0	25.0	20.0
Unit Capital Costs	**US$/t**	**17,644**	**17,000**	**21,650**
Life of Mine	t	40	40	40
Incentive IRR (post-tax)	*%*	*8.0%*	*8.0%*	*8.0%*
Incentive Margin (post-tax)	US$/t	1,500	1,425	1,815
Tax Rate	*%*	*25%*	*25%*	*25%*
Incentive Margin (pre-tax)	US$/t	2,000	1,900	2,420
Unit Operating Cash Cost	US$/t	3,500	3,200	3,500
Other Cash Costs	US$/t	250	250	100
Maintenance Capex	US$/t	500	500	500
AISC	US$/t	4,250	3,950	4,100
Incentive Price	**US$/t**	**6,250**	**5,850**	**6,520**
Cash Margin	*%*	*32.0%*	*32.5%*	*37.1%*

Sources: AKE, SMM

Various forms of Direct Lithium Extraction (DLE) are being developed, which have the potential to materially boost recovery rates and speed, resulting in increased lithium supply and lower costs from brine.

Naturally, this would lower incentive prices further.

Lithium Hydroxide

The lithium hydroxide price has fallen from a peak of US$85,000/t in 2022 to US$43,000/t spot (July 2023). This compares to an incentive price of ~US$7-8k/t for integrated producers and US$9-10k/t for unintegrated producers, assuming a normalised spodumene price of US$1,000/t.

Figure 12: Lithium Hydroxide Economics & Incentive Price

		Integrated		Unint.
Lithium Hydroxide Economics		Naraha (Jpn) (AKE)	Kwinana (Aus) (IGO)	China (normalised)
Total Capital Costs	US$m	84	920	
Production Capacity (LH)	kt	10	48	
Unit Capital Costs	**US$/t**	**8,400**	**19,167**	**6,500**
Spod Conversion Ratio	t:t		6.3	7.0
Spod Conc Price	US$/t		356	1,000
Spod Conc Cost	US$/t		(2,243)	(7,000)
Li2CO3 Conversion Ratio	t:t	0.95		
Li Carbonate Price	US$/t	5,850		
Li Carbonate Cost	US$/t	(5,558)		
Fixed Conversion Costs	US$/t	(1,500)	(2,500)	(1,000)
Unit Cash Cost	**US$/t**	**(7,058)**	**(4,743)**	**(8,000)**
Maintenance Capex	US$/t	(210)	(479)	(163)
Unit Total Cost	**US$/t**	**(7,268)**	**(5,222)**	**(8,163)**
Incentive IRR (post-tax)	*%*	*8.0%*	*8.0%*	*8.0%*
Incentive Margin (post-tax)	US$/t	672	1,533	520
Tax Rate	*%*	*23.0%*	*30.0%*	*25.0%*
Incentive Margin (pre-tax)	**US$/t**	**873**	**2,190**	**693**
Unit Total Cost	US$/t	7,268	5,222	8,163
Incentive Price (LiOH.H2O)	**US$/t**	**8,140**	**7,412**	**8,856**
EBIT Margin	*%*	*10.7%*	*29.6%*	*7.8%*

Sources: AKE, IGO | Unintegrated assumes SC at incentive price

Note, lithium hydroxide can be produced from both lithium carbonate and spodumene concentrate, so the capital costs and conversion costs are not directly comparable.

Using spot prices increases the incentive price required, due to higher spodumene cost. As the spodumene price falls towards incentive prices, it follows that hydroxide incentive prices will normalise. This appears to be ~US$10k/t on historical and incentive-based economics.

Conclusions from Incentive Prices

As there is ample prospective new capacity available for production at prices well below both incentive prices and the top end of the existing cost curves, it is logical that expanded supply will be brought to market. By definition, spot prices in excess of incentive prices encourages the continued addition of production capacity, to the point where the market price equals the marginal costs. The marginal producer at present has a cost of ~US$10k/t LCE.

From here, the approximate equilibrium prices flow:

- Lithium Carbonate (99.5% Li2CO3) US$10,000/t
- Lithium Hydroxide (56.5% LiOH.H2O) US$10,000/t
- Spodumene Concentrate (SC 6.0%) US$1,000/t

Market Implied Expectations

With spot prices being significantly higher than incentive prices, lithium producers are over-earning at present. Extrapolating current prices and margins is unsustainable.

Given current market valuations for the lithium companies, we find that the market is pricing in a spodumene concentrate price of US$1,750-2,000/t, for both PLS and IGO, depending on the choice of an 8-10% discount rate range. This is approximately double the incentive price of Australian and Canadian hard rock production, and 50% higher than the incentive price for high-cost Chinese lepidolite.

Similarly, the AKE share price is currently implying a lithium carbonate price of US$13,500-15,000/t depending on the choice of an 8-10% discount rate range. This is approximately double the incentive price of Argentinian, Chilean, Bolivian and Chinese brine production.

Figure 13: Market valuations and implied lithium prices

Company		PLS	IGO	AKE
Primary Product		SC6.0%	SC6.0%	Li2CO3
Lithium Assets	#	1	2 Li + 3 Ni	4
FY22 Production	kt	378	1,135	42
Target Production	kt	1,000	2,500	135-150
Mine Life	yrs	26	21	26
Cost of Production	US$/t	455	250	4,500
AISC	US$/t	575	350	5,500
Enterprise Value	A$b	12,696	11,240	9,629
Market Cap	A$b	14,481	11,093	10,014
Mkt Implied Price:		***SC 6.0%***	***SC 6.0%***	***99.5% LC***
At 10% WACC	US$/t	2,000	2,000	15,000
At 8% WACC	US$/t	1,750	1,750	13,500

Sources: PLS, IGO, AKE, Factset

We also note some lithium companies' overoptimistic use of *pre-tax* discount rates of 8% (5.6% post-tax) to derive the NPV of projects. We would argue that the risks involved with mining natural resources, and the lack of terminal value at mine sites, would be more appropriately assessed using a *post-tax* WACC of ~10%. This higher discount rate approximately halves the calculated NPV.

Conclusion

Ultimately, we view the logical outcome over time to be a strong supply response to the substantial spread in market prices vs incentive prices that currently exists, which will return prices and supply & demand to equilibrium in the coming years. As the market is currently extrapolating unsustainably high prices and margins, this represents considerable valuation risk to these companies.