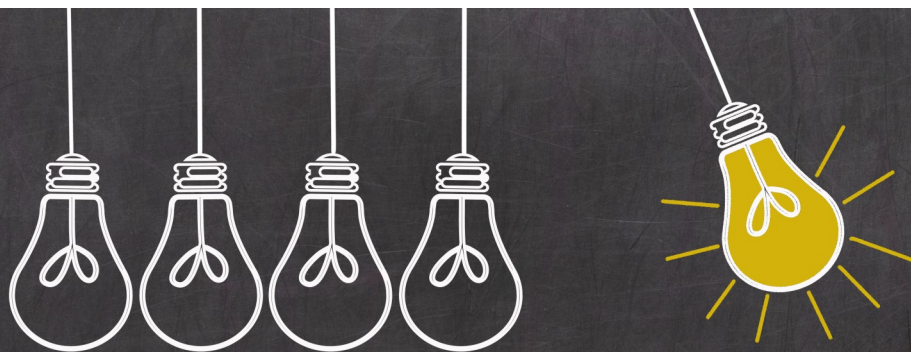


# Weekly Briefing

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## Battery Economics and Electrified Vehicles

- A critical enabler to the take-off stage of electrified vehicles is the battery: Its cost structure and energy to power driving range.
- The economics of batteries for cars runs through commodities markets and physical mine contracts.
- A preliminary assessment suggests that raw material costs are not likely to crimp battery pricing for EV manufacturers.

Lithium ion (Li) batteries in electrified vehicles are dependent on several raw material inputs, the most important of which are lithium and cobalt. These raw materials, especially cobalt, are expensive and can drive up the cost of batteries for EVs.

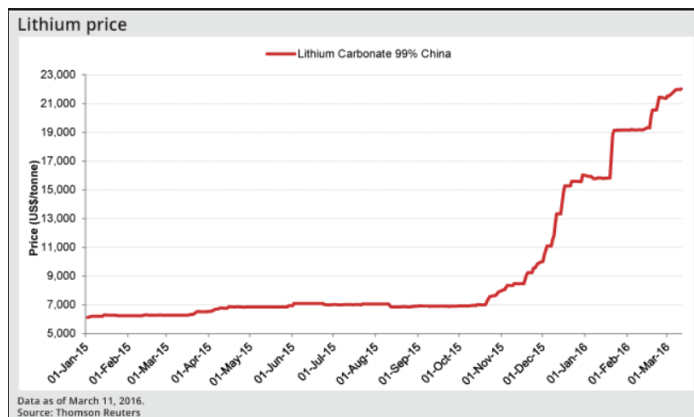
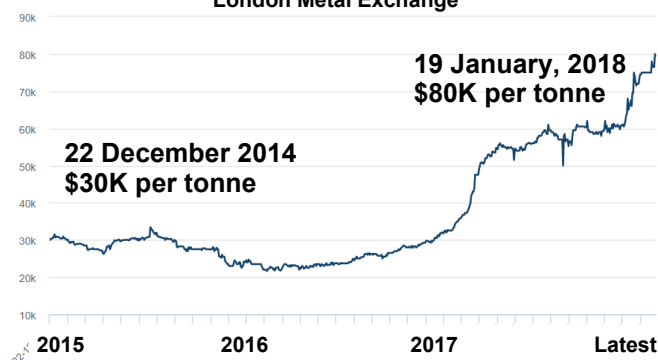
- The top chart shows cobalt pricing based on the London Metal Exchange (LME) quotes. As EV demand increased in China, so too did the LME pricing quotes, surging most recently to \$80,000 per tonne, up 267% since yearend 2014.
- LME cobalt prices could be misleading as many battery manufacturers are undertaking private transactions and buying physical contracts from mining companies in order to secure supply. As a result, it is possible that many of the large battery manufacturers can book cobalt discounts relative to the LME quotes.
- Lithium pricing is very opaque. A Reuters report from 2016 indicates that lithium carbonate pricing accelerated in late 2015 as China began to expand subsidies for EVs (see 2nd chart). Some information suggests that current prices remain in the range of \$20,000 per tonne, up about 200% since late 2015.

The volume of trading liquidity in these markets has yet to develop. Over time, transparency of volume and pricing should improve commensurate with EV market share. Finally, it is unclear whether certain battery suppliers are “hoarding” supply in excess of their requirements, thereby mitigating risk of any potential shortage or exposure to pricing spikes.

Recently, analysts at Citigroup estimated that 8.8 kilograms of cobalt and 37.2 kg of lithium are required in the production of a battery electric vehicle (see bar chart). Our own preliminary calculations suggest the cobalt requirement is somewhat lower than that. Even so, at 8.8 kg for cobalt, it does not appear to be an onerous constraint on EV battery costs.

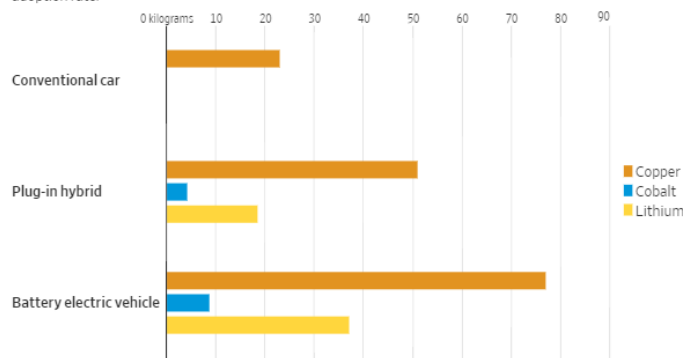
More work will be done on this question as we are able to obtain more transparency on pricing and costs of these raw materials and battery components.

Cobalt Prices, \$ per Tonne  
London Metal Exchange



Metals Mayhem

Electric cars are expected to stoke demand for raw materials, but much of the shift depends on the EV adoption rate.



Note: For a conventional lithium-ion battery with a nickel-cobalt-manganese cathode  
Source: Citigroup

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During January - November 2017, nearly 100,000 new battery electric vehicles were registered in the U.S., a small share of the 17+ million unit market, but up 44% from the same period in 2016.