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***Energy storage white paper** – more pressure on the lithium-ion battery material supply chain?*

Energy storage white paper
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Energy storage – more pressure on the lithium-ion battery material supply chain?

The focus of the lithium battery industry remains squarely on the electric vehicle market — both pure electric vehicles and hybrids — but competition for lithium-ion batteries and their battery materials could increasingly come from energy storage applications. With some commentators predicting looming supply deficits for lithium, cobalt and nickel, the prospect of a boom in the use of lithium-ion batteries in energy storage only adds to the potential strain on the battery materials supply chain.

Falling costs to help lithium-ion technology dominate in energy storage

Energy storage is needed to avoid wasting excess electricity from solar and wind power generation. Recent research published by a team from Imperial College London (ICL) shows similar capital cost evolution among technologies including lithium-ion and flow batteries.

The Imperial team found that the capital costs of home and grid-scale systems are generally heading towards $340/kWh (£263/kWh) once capacity capable of delivering 1TWh is installed for each technology. This is true for hydrogen fuel cells and lead acid batteries for homes, lithium-ion batteries on home and grid-scale, and grid-scale vanadium redox flow batteries. To place this in context, the UK consumed 337.6TWh of electricity in 2016.

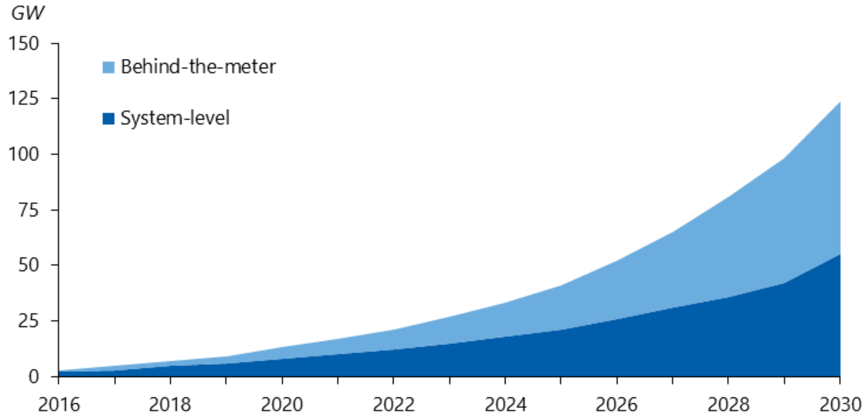
The costs of lithium-ion and nickel metal hydride batteries for electric vehicles converge at around $175/kWh after 1TWh is deployed. The ICL scientists forecast that vehicle lithium-ion batteries will be the first of any technology studied to pass the 1TWh milestone, in 2027. Home fuel cells, lead acid and lithium-ion batteries would be the next technologies to reach 1TWh, in 2038.

Similarly, the scientists forecast that the cumulative costs of installing 1TWh would be generally higher for home and grid-scale storage than for vehicles. Home lithium-ion batteries could be most expensive at $510bn to reach 1TWh in the UK.

Bloomberg New Energy Finance (BNEF) recently released a report forecasting that the global energy storage market will “double six times” between now and 2030, from a starting point of less than 5GWh in 2017, to more than 300GWh and 125GW of capacity by the end of the next decade. An estimated $103bn will be invested in energy storage over that period.

This growth for energy storage mirrors the market expansion that solar went through from 2000 to 2015, when the share of solar photovoltaic as a percentage of global power generation doubled seven times. This growth will be driven by cost reductions for batteries and associated systems, and a rising need for more flexibility to manage the operation of grids increasingly supplied by intermittent wind and solar power, according to BNEF.

Cumulative energy storage deployments, 2016-30



— *BNEF*

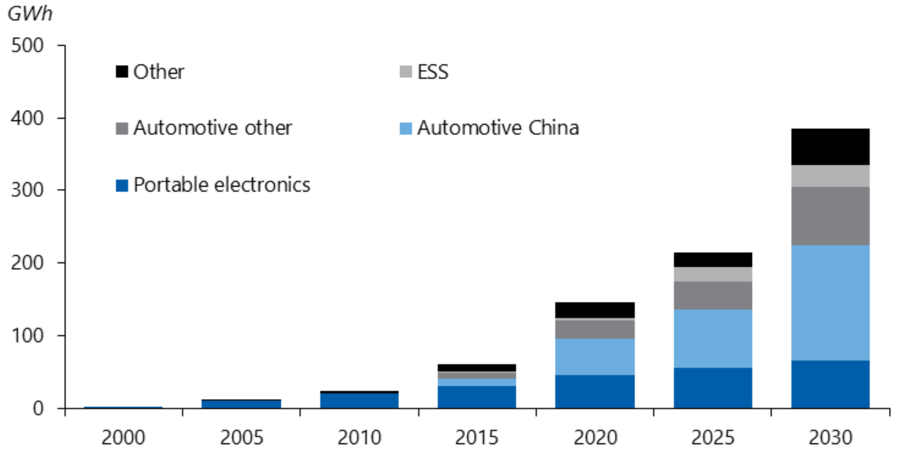
Electric vehicles will drive demand for lithium-ion batteries to 2030

Forecast growth rates for energy storage are impressive, but in terms of demand for lithium-ion batteries it is from a low base. As such, it is unlikely that energy storage applications will make too much of an impact on the rechargeable battery sector in the next 10 years or so. Energy storage applications are forecast to grow by more than 20pc/yr between 2020 and 2030, but will still account for less than 10pc of the lithium-ion battery market in GWh terms by 2030.

In contrast, automotive applications for lithium-ion batteries are predicted to grow at a slower rate of 15-20 pc/yr over the same period and will represent more than 60pc of the market. Within the automotive sector, China is forecast to account for around two-thirds of battery demand in electric vehicles by 2030.

Portable consumer electronics and other more traditional uses for lithium-ion batteries — such as power tools and other appliances — represented 65pc of the market in 2015, but with growth expected to average 6-7pc/yr, their share of the market drops to around 30pc by 2030.

Lithium-ion battery market by application, 2005-30



— *Avicenne; Argus*

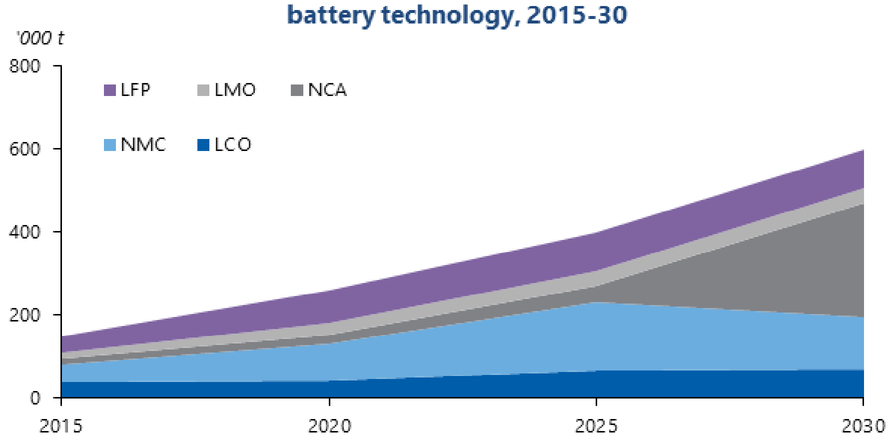
The race is on for battery material supplies

The predicted growth in the lithium-ion battery industry is likely to put increasing pressure on the supply chain for battery materials, both for the cathode (lithium, cobalt, nickel and manganese) and the anode (graphite). Using predictions for the uptake of the different lithium-ion battery technologies and their respective metal contents provides a basis for forecasting the total consumption of cathode materials (as shown in the graph), as well as demand for the individual metals.

Lithium containing nickel manganese cobalt (NMC) is forecast to have a 35pc share of the lithium-ion battery market by 2020, followed by lithium ferrous phosphate (LFP) with 30pc, lithium cobalt oxide (LCO) with 15pc, lithium manganese oxide (LMO) with 11pc, and nickel cobalt aluminium (NCA) with 9pc. By 2030, NCA batteries have taken over with a market share of around 45pc, followed by NMC (21pc), LFP (16pc), LCO (12pc), and LMO (6pc).

In terms of total demand for lithium-ion cathode materials, the market is forecast to grow from roughly 150,000t in 2015 to 260,000t in 2020, 400,000t in 2025 and 600,000t in 2030. The approximate compound average growth rates would be 12pc, 9pc, and 8pc in 2015-20, 2020-25, and 2025-30, respectively. The growth rate slows as the decade progresses, but this has more to do with the fact that the earlier growth is from a low base rather than any significant slowdown in the take up of electric vehicles and other applications that use lithium-ion battery technology.

Forecast demand for lithium-ion cathode materials by battery technology, 2015-30



— *Avicenne Energy; Argus*

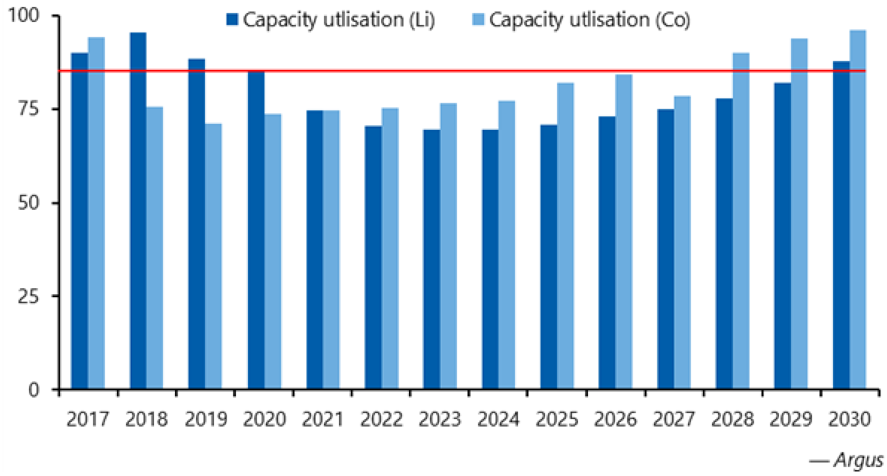
Lithium tightness in the short term; cobalt a problem for later

The markets for the major cathode materials have different dynamics when it comes to the impact of the battery sector. The battery industry accounts for approximately half of lithium and cobalt demand, but less than 5pc of the nickel and manganese markets at present. By 2030, batteries could represent 75pc of lithium demand, 70pc of cobalt demand, but still only around 10-15pc of nickel and manganese consumption. So the rapid expansion of the electric vehicle and energy storage sectors, and the demand for lithium-ion batteries to power them, will have a disproportionate impact on the lithium and cobalt industries compared with nickel and manganese. But the supply of nickel sulphate — the form of nickel used in batteries — is being constrained by the dominance of ferro-nickel for the stainless steel industry, which could lead to some supply issues until more dedicated nickel sulphate capacity is brought on line.

Argus forecasts for lithium and cobalt capacity utilisation show near-term tightness in the lithium market easing toward the middle of the next decade before returning towards 2030. Using 85pc capacity utilisation as a benchmark level — which could be considered high given the levels of capacity utilisation in China — utilisation rates for lithium remain above that level until 2020, before dipping to around 70pc by 2023-24 as a number of new projects come on stream.Lithium capacity utilisation then ramps up steadily towards 90pc in 2030 as demand for lithium in batteries continues to forge ahead.

For cobalt, capacity utilisation was an estimated 95pc in 2017, with cobalt prices strengthening significantly during last year to now be more than 250pc higher than in January 2017. Capacity utilisation drops significantly to 75pc this year, following global mining firm Glencore's announcement of a doubling of output from its various cobalt producing operations by 2019 — potentially providing an additional 30,000-35,000 t/yr of cobalt. A distinct lack of projects in the pipeline — perhaps because cobalt is a by-product of nickel and copper mining — means that capacity utilisation returns quickly to 85pc by the mid-2020s and reaches 96pc in 2030. This is despite the preference of the electric vehicle industry for lithium-ion battery chemistries that use less cobalt — 6-7pc cobalt in NCA batteries compared with 60pc in LCO batteries.

Forecast lithium and cobalt capacity utilisation, 2017-30 (%)



Although lithium managed to snag the naming rights for lithium-ion batteries — as it is the lithium ions that pass between the cathode and anode during charging/discharging — whichever of the lithium-ion battery technologies is used, the cathode only contains 7pc by weight of lithium. The lithium industry has been gearing up for the electric vehicle boom and it appears that there will be sufficient supply for the foreseeable future owing to the number of new projects and capacity expansions in the pipeline.

The same cannot be said for cobalt or nickel, but for differing reasons. As cobalt is a by-product, supply does not necessarily track demand, and there are few primary cobalt projects in development. For nickel, the problem is more to do with the dominance of the stainless steel industry, which accounts for around two-thirds of demand. As batteries represent less than 5pc of nickel consumption at present, there is little incentive to commission specific projects to produce nickel sulphate. A significant rise in the premium for battery-grade nickel might change the market dynamic in the coming years as battery materials demand surges.

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