

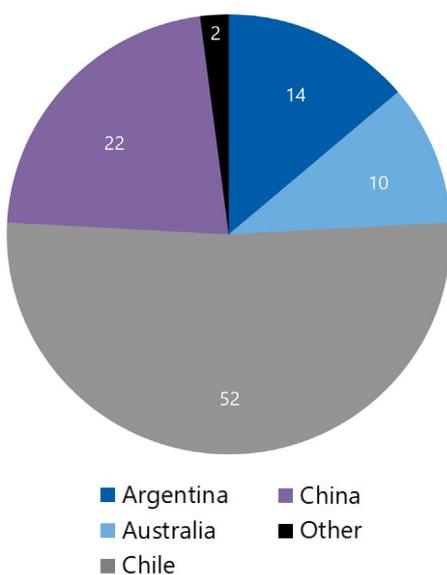
In little more than a decade, lithium has gone from being a rather staid industrial mineral used principally in ceramics and glass applications to a shiny technology metal vital to the development of alternatively fuelled vehicles. With production of electric and hybrid vehicles forecast to increase exponentially in the coming years, the main challenge for the lithium industry appears to be to ensure that supply matches the growing demand.

Chile dominates global lithium reserves

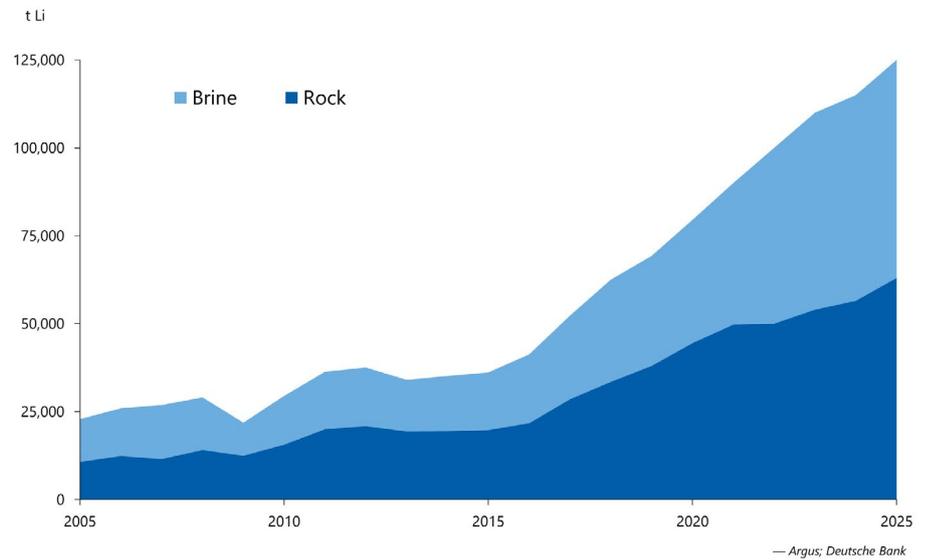
Just over 50pc of global lithium reserves are found in Chile, which is the world's largest lithium producer, according to data from the USGS. Argentina and Bolivia add a further 14pc, giving what is known as the 'Lithium Triangle' almost two thirds of world lithium resources. China and Australia are the two other countries with major lithium reserves, accounting for 22pc and 10pc of the global total respectively.

Lithium brine operations are located within the 'Lithium Triangle', as well

Lithium reserves by country, 2016 (%)



Global lithium production by source, 2005-25



as China and the US, while hard rock lithium deposits are mostly mined in China, Australia, Brazil and some African countries. Bolivia has a number of large lithium salar deposits, but many of these have magnesium to lithium ratios that currently make lithium extraction uneconomic.

China, the world's leading producer of lithium ion batteries, has substantial lithium resources in the forms of brine and the hard rock deposits, spodumene and lepidolite. China has salt lakes in Qinghai province, spodumene resources mainly in the Xinjiang region and Sichuan province, and lepidolite in Jiangxi province.

Brine vs. hard rock – 50:50

Production of lithium is split between brine and hard rock operations, currently at around a 50:50 ratio, after brine's share of production fell from around 55pc over the last 2-3 years. Hard rock projects are expected to be the first to start production towards the end of the decade, so the share of production held by brine will fall to around 45pc. However, a significant

expansion in brine output is expected between 2020 and 2025, by which time the split in production between brine and hard rock operations will move closer to 50:50 again.

Lithium brine deposits generally have better economics in terms of operating costs, as lithium is already isolated and in solution within the deposit, negating the requirement for drilling, blasting, crushing and physical separation. Brine operations also utilise solar evaporation to concentrate the brine within a series of ponds prior to purification. The downside of brine operations is that they are more capital intensive than hard-rock operations, incur significant lead times to meaningful production because of technical and geographical issues, require economies of scale and are influenced by evaporation rates (weather dependence). The advantages of hard rock deposits are their low capital intensity, low technology requirements and short processing times, while the disadvantages are high operating costs and the relative lack of high-grade deposits.

With global lithium demand forecast to increase strongly in the next 5-10 years, it is likely that hard rock operations and projects will be able to respond to market conditions much faster than their brine equivalents. The Greenbushes mine in Australia, which is jointly owned by Albemarle and Tianqi, is the world's largest spodumene operation and accounts for almost 40pc of global lithium supply. New hard rock projects are also close to commissioning with the Mt. Cattlin and Mt. Marion projects, both in Australia, starting up in late 2016/early 2017. By contrast, the lead times for brine projects are much longer and, while there are planned expansions at existing brine operations – e.g. La Negra in Chile – the bulk of new brine production is likely to come on stream later in this decade and beyond.

Electric vehicles drive lithium demand

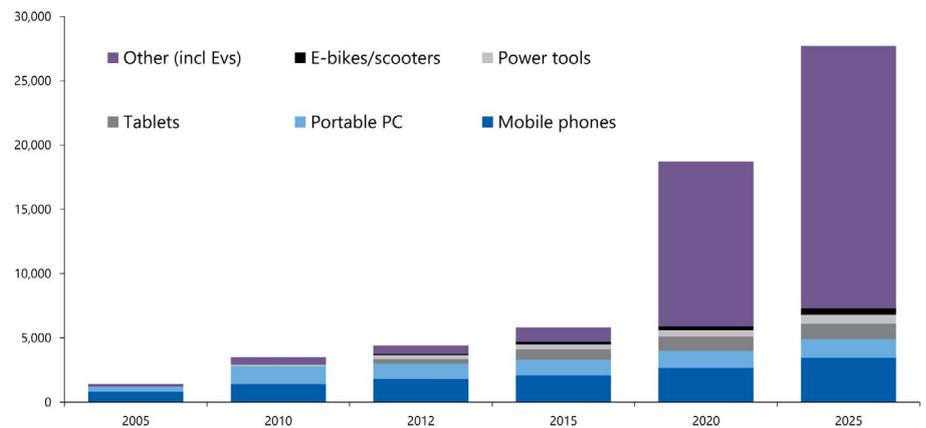
Lithium consumption is being driven by the rise in the lithium-ion (Li-ion) battery market, which has increased to more than 70GWh from less than 10GWh a decade ago. Some forecasters expect the market to reach more than 223GWh by 2025, a threefold increase from current levels. The strongest demand growth for lithium over the next 10 years is expected to come from Li-ion batteries used in electric vehicles, including electronic bikes, as well as energy storage applications. Non-battery applications are growing more slowly. Growth will be supported by the lower cost of batteries and by global efforts to reduce carbon emissions. Batteries accounted for 35pc of all lithium use in 2015, up from 25pc in 2007. The major applications for batteries in 2015 were electric vehicles at 25pc, phones at 19pc and portable personal computers at 16pc.

Rising output of electric vehicles has led to a rapid increase in lithium demand. In China, for example, electric and hybrid vehicle production rose by nearly 20pc from a year earlier to 212,000 units in January-June 2017. Under a new

government scheme, all carmakers in China with capacity of more than 50,000 units/yr must ensure that electric vehicle sales account for 8pc of their overall sales in 2018. This requirement increases to 10pc in 2019 and 12pc in 2020. The mandate is intensifying competition in the electric vehicle sector and further boosting demand for lithium batteries. China's domestic demand for lithium-ion batteries is expected to reach 31GWh this year, up by 11pc from 2016. Li-ion battery demand is then forecast to increase to 125 GWh/yr by 2020, according to China's ministry of industry and information technology, a CAGR of more than 40pc over four years.

Global demand for li-ion batteries in volume terms is forecast to grow at 25pc/yr between 2015 and 2020, before slowing to around 10pc/yr from 2020-25. The growth rates for battery consumption, if electric and hybrid vehicles are removed from the forecast, fall to just 5pc/yr and 4pc/yr respectively. This illustrates the importance of alternatively-fuelled vehicles for the lithium industry in the coming years.

Global demand for lithium-ion batteries, 2005-25 (mn cells)



Source: Avicenne Energy

Lithium prices stable, but cobalt on the rise

Demand for batteries and their associated technologies has been a game-changer for producers of lithium,

cobalt and graphite, turning them into outliers at a time when other commodities are undergoing price falls and declining investment, according to the Australian government's commodity forecaster the Office of the Chief Economist (OCE). "Time and technological change will show whether the battery boom can drive wider change in global markets and energy models. Investment is being drawn by the promise of electric vehicles, and by the potential for community-generated solar power to displace grid monopolies and fossil fuels," the OCE said. This investor interest is, in turn, generating sizeable funds dedicated to further research and development. "Commodity demand will be strong in the short term, but long-term prospects for battery technology are still in motion. The potential opportunities are vast, and investment and production decisions of today could cast a long shadow into the future," it said.

According to Chilean lithium developer Sociedad Química y Minera de Chile (SQM), global demand for lithium

will exceed 500,000 t/yr on a lithium carbonate equivalent (LCE) basis by 2025, up from the current level of 200,000 t/yr LCE, for a growth rate of roughly 10pc/yr. This rise in demand will be fuelled by the growing use of lithium-

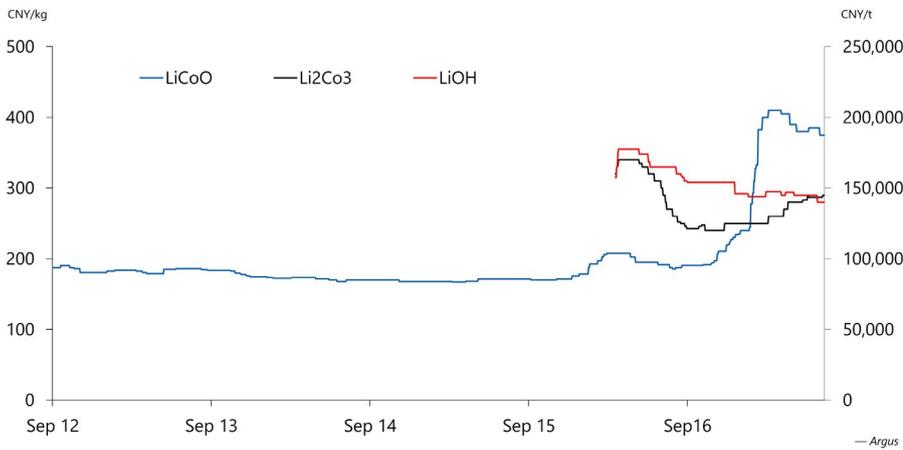
based batteries in the automotive industry, which is expected to boost lithium demand for many years.

All of this could be expected to have a positive effect on lithium prices in the short to medium term. However, Chinese lithium prices have been relatively stable in 2017 as supply has managed to keep up with burgeoning

demand, although lithium carbonate prices have increased by 15pc since the beginning of the year. By contrast, prices for lithium cobaltite (LiCoO) have risen by almost 60pc in 2017 alone, driven by a similar increase in cobalt prices. In the short to medium term, it is possible that lithium prices will also rise as production capacity will have to increase substantially to meet forecast

demand. This increase is likely to come from hard rock projects to begin with, because of the longer lead times and higher capital requirements for brine projects. Significant lithium brine capacity should then be commissioned towards the end of the decade, which will be enough to cope with forecast consumption and to stabilise prices.

Chinese lithium prices, 2012-17



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