SG HISCOCK & COMPANY

SGH20 Insights

Graphite - the other side of the battery story helping power EVs

"We always overestimate the change that will occur in the next two years and underestimate the change that will occur in the next ten. Don't let yourself be lulled into inaction." *Bill Gates*

Key insights

- We believe Electric Vehicles (EVs) will be a large and growing addressable market and attractive investment theme.
- The challenge is finding ways to play it in Australia. In our view the battery metal producers are best positioned. Similar to Rockefeller fuelling the Model T boom, we see them providing the "new gasoline" for the EV industry.
- It is vital when investing in resource companies to identify companies that have a large high quality resource, are low on the cost curve, well capitalised and led by experienced and focused management.
- Out of the battery metal companies listed in Australia we see Syrah Resources as best positioned.

Linking themes to stocks and investible ideas

Identifying and analysing industry themes is an important part of our investment process, as it helps in understanding the realignment of industry profit pools, new segments of growth, and potential winners and losers. Most themes emerge over time and can be identified with a reasonably high degree of visibility. The challenge as investors is identifying whether the theme really matters for markets. To do this, we focus on the:

- Speed of change – how quickly is the theme growing?
- Scale of change – how big is the market opportunity?
- Source of change – what are the catalysts and drivers?

Ultimately, we are looking to identify themes that matter, link them to stocks with a competitive advantage and investable ideas that meet our fundamental process and that are well managed.

It would be hard to have not heard or read about EV's in the last 12 months. Tesla, Lithium & Cobalt are now part of the vernacular; the vanguard of the EV theme. Following closely, large and established automakers are issuing statements committing to commercial production of EVs accompanied by large amounts of capital: they are not just talking the talk, but walking the walk. In viewing the saturation of news flow that's accompanied this shift, Bill Gates' words (above) spring to mind. Although the longer-term impacts of EVs may transform society, the industry is nascent as a global commercial reality. In light of this, we have immersed ourselves in the EV industry to better understand the emerging trends and where the investment opportunities lie. Here we share some of our thoughts.

Model T to Model 3: Ford to Musk

Henry Ford did not invent the combustion engine, but his flagship Model T revolutionised automobile production and made it affordable to the masses. In doing so, he became synonymous with the assembly line and automated manufacturing. In a similar vein, we see Elon Musk's Tesla as revolutionising the EV industry. Tesla's Model 3, starting at US$35,000, is a foray to mass produce an affordable electric vehicle, making the Tesla brand mainstream. In a mass market context Tesla is a very small player. However, more broadly, the Tesla brand has become synonymous with EVs and been instrumental in shifting the political and social discourse towards EVs and battery technology.

As an early mover, Tesla is broadly viewed as a disruptor and EV market leader. This has seen its market capitalisation increase to US$56bn, eclipsing Ford's market cap despite generating just 8% of Ford's sales (FY18 consensus estimates). However, we increasingly question Tesla's ability to dominate the automotive industry as Ford did. There are clear and growing signs that established car manufacturers are embracing EV technology. These automakers are better capitalised, have more manufacturing expertise, are better leveraged to scale, and have existing design capabilities and distribution networks.

Figure 1: Market is pricing Tesla for success, but is it overvalued?

Stock	Ford	GM	Tesla
Price (USD)[1]	13.0	43.00	334.8
Mkt Cap (USD) Bn	51.8	61.1	56.3
Revenue (USD) Bn	144.0	141.7	19.7
EV/EBITDA (x)	4.1	2.9	332.7
Div Yield (%)	4.6	3.5	-
Price to Book (x)	1.56	1.43	11.9

Source: Bloomberg, SG Hiscock & Co (at 11/01/2018). FY18 Consensus estimates.

In many respects, Tesla has become a proxy for the broader EV thematic. This has been dubbed the "Tesla effect", and it is seeing a reassessment of the automotive supply chain and infrastructure globally, which requires massive investment. Morgan Stanley estimate that by 2040 the total investment in the EV supply chain (including auto and battery manufacturing, metals & mining, capital goods and electric utilities) could total US$2.7tn. This begs the obvious question: which companies are best positioned to benefit?

One of the largest beneficiaries from Henry Ford's popularisation of the car was John D Rockefeller, the owner of Standard Oil. He amassed a vast fortune, many multiples the size of Ford's, by owning the fuel source for the combustion engine. To this effect, Lithium (and we would argue broader battery metals), have been described by Goldman Sachs as the 'new gasoline', 'a key enabler of the electric vehicle revolution'. This is particularly relevant to the Australian investment landscape, with battery metals miners able to service this large and growing addressable market.

The EV Market

EV penetration rate estimates have a wide range throughout the market. Bloomberg project 34% of all cars on roads to be EVs by 2040, with the bulk of these coming from Europe and China. Although there is considerable debate over the rate and timing of penetration, the factors underlying the EV market are strong and compelling. At its core, we expect the ramp up to be driven by government and the private sector aligning to roll-out 'greener' energy initiatives. This is already most evident in China, where there is strong government policy and funding for EVs, as the country looks to dominate EVs like the Americans did the combustion engine in the early-mid twentieth century.

We see EV penetration rates being driven by two main factors:

1. **Range parity**: EVs being able to compete with fossil fuel vehicles on range and cost per kilometre; and
2. **Cost parity**: EVs cost relative to fossil fuel-driven vehicles. Critical to this is affordability and the ability to drive down the price of batteries and other inputs and leverage economies of scale.

More broadly we see growth in the EV market as driven by:

- **Government policy and regulation**: Global emissions standards are increasing. Greater taxes and restrictions are being placed on combustion vehicles and subsidies given for EVs. For example, Norway has banned the sale of fossil fuel powered vehicles beyond 2025 – there are many cities and countries implementing similar policies given concerns for pollution.
- **Infrastructure investment**: Public policy and private partnerships will be necessary to build out the electric transport networks. Similar to the rollout of the early electric utility grid in the 1880's-90's, charging stations and grid upgrades will be required to leverage the full benefits of EVs and the shared, autonomous ecosystem they will bring.
- **Industry investment**: As highlighted in Figure 2, traditional auto manufacturers are responding to EV development and competition by investing and partnering in technology and the supply chain.
- **Sales momentum**: In 2016 the global EV fleet surpassed 2m vehicles and is estimated by the International Energy Agency to grow by around another 1m vehicle in 2017. Economies of scale are critical to reducing cost and making EVs available to the mass market.
- **Brand**: Brand awareness and development is key – these businesses need to deliver value (quality at a reasonable price, as well as reliability). For example, Tesla is synonymous with innovation and technology and resonates strongly with consumers who are early-adopters.

Figure 2: Auto Manufacturers EV announcements

Source: Syrah Resources, SG Hiscock & Co

We see these underlying drivers as likely to provide strong and sustainable growth over the coming decades. Given Australia's natural bias to the resources sector and lack of direct listed investment opportunities in many parts of the EV supply chain, it's important to better understand the battery technology that will power these vehicles and the likely demand dynamics for battery metals.

The Battery

Lithium-ion batteries (LIBs) are currently the primary power source for EVs given their reliability and safety. LIBs comprise two main components: the anode and the cathode.

There are several different types of cathodes produced, depending on the desired battery qualities. Figure 3 outlines

the various forms of LIBs that dominate the market today. What's clear is the chemistry of various batteries use varying percentages of cathode material inputs.

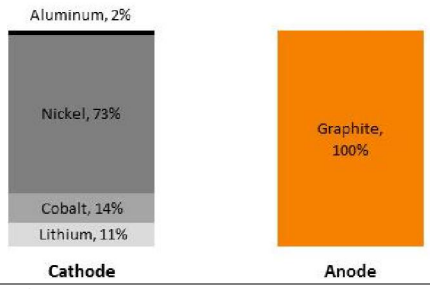
Figure 3: Cathode metals chemistry used in Lithium-ion batteries

	Cathode (in varying percentages)				
Battery Type	Cobalt	Manganese	Nickel	Aluminium	Example
NCA	15%	0%	80%	5%	Tesla Model S
LCO	100%	0%	0%	0%	Apple iPhone
LMO	0%	100%	0%	0%	Nissan Leaf
NMC	33%	33%	33%	0%	Tesla Powerwall

Source: Visual Capitalist, SG Hiscock

Figure 4 shows the typical battery used in the Tesla Model 3. It highlights the mix of cathode and anode materials used, and that 100% of the anode material is graphite. The key thing to take from this is that for safety and performance the cathode and anode must be balanced, and whilst the cathode material inputs can vary by battery type, graphite is battery chemistry agnostic and the key anode input – a point we think is often overlooked. This is important because more graphite is used per kilowatt hour in batteries than each cathode commodity. Large size, high performance lithium-ion batteries can require more than four times the graphite feedstock compared to lithium in a lithium-ion cell. This expands to nine times the amount of feedstock relative to cobalt.

Figure 4: Active materials in Tesla Model 3 Lithium ion battery



Source: Bloomberg New Energy Finance

Graphite market dynamics

Graphite comes in two forms: synthetic and natural, which is processed into natural spherical graphite. Synthetic graphite is costly to produce given the large amounts of electricity used in the manufacturing process, which also raises environmental emissions concerns. In China, which currently produces the majority of the world's anodes and anode materials, this is an increasing issue given the Government's environmental and anti-pollution reform agenda introduced as part of the latest China Party Congress. Mandated production cuts are seeing Chinese anode manufacturers switching to natural graphite, with lower quality and higher cost graphite mines being closed. This has resulted in a significant increase in the price for natural flake graphite in the last 12 months, coming off near 10 year lows.

We expect this trend to continue as prices reflect the changing market dynamics and that:

- Natural flake graphite prices still remain around a quarter of the price of synthetic graphite, even after the recent rises,
- Increasing use of natural graphite (over synthetic graphite) will assist in lowering the cost of batteries, which is a central focus for automakers,
- China's demand for flake graphite is increasing at the time of reducing Chinese domestic supply; and,
- Global auto manufacturers are seeking to reduce supplier risk by geographically diversifying and reducing their dependence on China.

In thinking about future demand for graphite, it is important to recognise base load demand is determined by industrial market applications, primarily in the steel industry, and currently accounts for c.65-70% of the c.600ktpa graphite demand. We expect growth in demand from these applications to be modest (to slightly down) over the next 5-years with incremental demand driven by growth in batteries and decline in Chinese domestic supply. This is different from lithium and cobalt which have little alternative use outside batteries, and are much more leveraged to the rise in battery demand, as has been evident by the 2-3x multiple increases in their prices versus flake graphite in the last 12 months. We see the lack of material base load demand as adding to the potential volatility and adding risk in these purer play battery material commodities. The risk is the sharp increase in commodity prices incentivises new players and capital to enter the market. Whilst we expect the supply of natural graphite to move into balance over time as prices rise, reflecting the changing dynamics, we think it potentially provides a more rational industry structure to invest in. This is particularly true for natural graphite players located outside China, who are able to supply to non-Chinese auto and battery manufacturers.

Will things change?

The risk of lithium ion battery technology being disrupted by a next generation battery or new technology is an important consideration, particularly given the allure of the market opportunity and large amount of capital from both the private and public sectors being invested in EV technology.

We see it as unlikely that LIBs will be replaced as the dominant technology in the short-medium term (next decade and potentially longer). We think of LIBs as a platform, where technology advances in the short-medium term will support and enhance the platform rather than replace it. This is largely due to the huge amounts of capital invested globally in this platform to power the EV revolution.

Despite talk of solid-state battery technologies from groups such as Toyota, it is important to remember that LIB technologies were first proposed in 1973 by Adam Heller, but it wasn't until 1991 that Sony released the first commercial battery. Urich Elichhor, the Head of R&D at Volkswagen, the

world's largest carmaker, recently echoed similar sentiments around the lead-time required for new technologies to become commercially accepted. In discussing the potential for lithium sulphur and lithium-air chemistry, he predicted it could be 15-years for that technology to become commercially available.

Specific to graphite, changes to anode technologies within the lithium ion platform are also a risk. However, our insight from discussions with industry contacts suggests graphite will remain the key input with materials such as silicon only likely to play a minor (<10% and closer to 5%) role in the short-medium term. Silicon's primary benefit is it increases the cycle life of the battery, meaning more charges can be obtained from the same battery. However, it faces the problem of generating higher temperatures and expanding in the battery, which jeopardises safety and reliability, which is paramount for automakers.

Syrah Resources (SYR)

We think the Electric Vehicle market is a large and growing addressable market and attractive investment theme. The challenge is finding ways to play it in Australia. In our view the battery metal producers are best positioned. Similar to Rockefeller fuelling the Model T boom, we see them providing the "new gasoline" for the EV industry.

As a general rule, we think over the long-term that resource companies do not have pricing power. The world is well endowed with most resources and, if the incentive price is high enough, supply will respond. It is therefore vital in investing in resource stocks to identify companies that:

- Have a large, high quality resource
- Are low, and preferably at the bottom, of the cost curve
- Are well capitalised
- Led by experienced and focused management.

Out of the battery metal companies listed in Australia we see Syrah Resources as best positioned. As a supplier of high quality graphite, the Balama mine in Mozambique will be the largest natural graphite mine globally from 2018. It is a long life asset that will be at the bottom of cost curve in the first year of production, with optionality to expand. Sales agreements have been signed with traditional battery market customers, as well as off-take agreements with industrial customers for base load demand, giving it a secondary market many of the purer play battery metals players don't have. The opportunity to capture additional cash margin and move downstream and establish a core position in the battery supply chain through building a spherical graphite plant in the US, when coupled with the processing of graphite from Balama, provides additional optionality and potential growth. Strategically, this would make Syrah the first integrated battery anode material producer of significant scale outside China, a major competitive advantage in helping battery and auto manufacturers diversify and secure their supply chains.

Management changes over the last 12-18 months (including the appointment of Shaun Verner as CEO) have given us greater confidence in Syrah's operational capabilities and focus. Strategically, we also view the collaborative relationship for battery testing and product development with Cadenza Innovation, a leading innovator in downstream battery technology, as positive. Christina Lampe-Önnerud, Cadenza's CEO and Founder recently joined Syrah's board and is a globally regarded innovator and entrepreneur in battery technology.

Andrew Gillies
Analyst
SG Hiscock & Company
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