Battery Technology – An Industry of the Future?

On Wednesday 14th April, we sat down with Mark Copley of Warwick University to discuss the growing battery sector, and took a deep dive into some of the technologies underpinning its future development.

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We fielded many questions from the audience, not all of which we had the time to answer fully on the day – if you have additional queries on the below, feel free to message us at info@metal.digital for more information.

1. What are the key metals within Electric Vehicle batteries and what role specifically does Nickel play?

Nickel, Manganese and Cobalt are the key metals in Electric Vehicle (EV) batteries. One of the main battery technology types is the NMC battery which stands for Nickel-Manganese-Cobalt. The NMC battery has evolved from NMC111 to NMC 532 to NMC 622 and finally NMC 811 where the numbers following NMA represents the ratio of the metals e.g., NMC 811 contains 8-parts Nickel, 1 part Manganese and 1 part Cobalt. As can be seen from the evolution of the NMC battery there has been a move to a higher and higher percentage of Nickel in the batter due to its positive effect on battery capacity and energy density.. NMC 811 has a capacity of approximately 200 mAh/g compared to NMC 111 which has a capacity of only approximately 150 mAh/g. Obviously with batteries, there is no single defined answer for what will continue to happen in the future, but there appears to be a trend towards higher Nickel content.

2. Will the supply of key metals in battery technology meet the forecast of adoption?

With the combination of what is being mined and the potential of recycling, combined with the adoption of other technologies such as fuel cells and sodium ion taking up applications, it strongly suggests that the supply of the key metals will be sufficient in the foreseeable future, allowing forecasts and adoption goals to be met.
In the short term, however, there may be some shocks. Decades of underinvestment in the sector, and the rapid emergence of the technologies spurring demand, has meant that there will be some inelasticity of supply.

3. Are there any replacements to Nickel use in battery

technology?

Currently there is no commercially viable substitute for Nickel use, which partly invites the answer to Question #3 above. However the closest potential substitute is Manganese. A high voltage spinel Manganese structure is being researched but needs a complementary electrolysis system to go with such a battery, primarily due to large amounts of decomposition and lifetime failure. Consequently, more work needs to be done to completely commercialise the technology!

4. What is UKBIC?

UKBIC stands for the UK Battery Industrialisation Centre and is a part of the UK government's Faraday Battery Challenge programme to fast track the development of cost effective, high performance, durable, safe and recyclable batteries. The £130 million unique facility provides the link between promising battery technology in in the laboratory or protocol stage, and successful mass production[1].

5. Are Solid-state Batteries vanadium based?

A solid-state battery uses solid electrodes and a solid electrolyte. The materials used include ceramics (e.g., oxides, sulfides, phosphates) and solid polymers. They do not contain vanadium.
However, there is a vanadium redox battery, which is a type of rechargeable flow battery. Its main uses are in grid energy storage due to their bulky nature.

6. Why are the Japanese (eg.Toyota) promoting the use of solid-state batteries if there are numerous problems?

Toyota has not released a solid-state battery to date (21/4/21). However, Toyota plans to be the first company to sell an EV equipped with a solid-state battery and are set to reveal their first prototype this year. Toyota stands at the top of the global heap with over 1,000 patents involving solid state batteries and are being further incentivised with the Japanese government putting together a $19.2 billion fund to support firms doing research in this field[2].
Some of the disadvantages include a high cost that is 3 times greater per kW than li-ion batteries, scalability issues and the fact that a suitable material for the solid electrolyte with ideal ionic conductivity properties has yet to be found[3].
However solid-state batteries have a wide array of advantages that displace the numerous problems. It takes roughly 10 minutes to charge an electric vehicle, reducing changing times compared to other EVs by two-thirds. Furthermore, a trip of 500km can be achieved with just one charge, they are smaller in size than lithium-ion batteries (providing more leg room) and have a greater safety element due to the lack of flammable electrolytes[4].

7. What is the life time of batteries– Any mileage drop-off with age?

There is approximately a 10-year guarantee with battery packs on average. However, there is a mileage drop-off with age due to a buildup of elements such as dendrite, and decomposition with time and charge discharge. Considerable research is going into battery sensors, where you will be able to know exactly what is going on in each cell, allowing individuals to observe which cell is failing, permitting a direct replacement of the cell, or turning it off altogether.
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Additionally, research into the optimisation of battery material is occurring. A lot of NMC batteries can benefit from further inorganic coatings, increasing the lifetime, improving conductivity and allowing the use of higher voltages which can increase greater energy densities.

8. How does blockchain capture ESG data in the third world?

Blockchain allows us to add encrypted, immutable data regarding ESG measures onto the network, across each stage of the supply chain, from miner until the end consumer. This can include information such as origins, carbon emissions, audit documents, refiners used, date of mining/refining etc. Investors can then use that information, in conjunction with other information they have about the miners/refiners/countries in question, to make better-informed, ESG-conscious investment decisions.

It is true, however, that the realities on the ground can sometimes make this challenging. The prevalence of so-called ‘artisanal & small-scale mining’ (ASM) in certain countries means that the formal networks and checks necessary to build up accurate data on the blockchain are not always present.

There are two responses to this. Firstly, due to the ease with which participants can add to the blockchain, and the transparency that is afforded by the distributed ledger, it is easier than one might think for producers to upload data about their products and auditors to inspect that data, even when the participants have less technology at hand than major mining concerns. Compare, for example, the widening use within agriculture, where small-scale farmers are increasingly able to harness the power of blockchain to access global supply chains[5]; and particularly the case of coffee farmers, who are already able to give consumers thorough information about their product, even when they sell via Big Coffee middlemen[6].

Secondly, the blockchain, or lack of it, can also act as a ‘negative screening’ tool with regards to ESG. That is to say, industry, consumers and investors can use the absence of reliable blockchain data to exclude certain producers who are less transparent about their production methods. In the case of battery manufacturing, OEMs may avoid procuring metals from those areas where blockchain coverage is patchy, functioning as an effective negative screening measure, whilst also incentivising producers to better represent their methods on the blockchain in the future.

9. Can the same logic be applied to record CO2 emissions?

Yes absolutely, CO2 carbon emissions is something you can transparently capture through Blockchain for ESG purposes. There are a number of methodologies being developed to measure carbon footprints for specific metals along their supply chain. In a lot of cases the metal ore consists of a mixture of metals, it does not purely consist of one metal. Therefore, separation of these meals must occur, creating challenges in the methodology of measuring the emissions, but in terms of capturing and storing CO2 data on the Blockchain, it is relatively simple and so we expect this to start occurring on a more frequent basis in the near future.

Complied by Jay Kumar - NTree International

References

Some information taken from BrightTALK presentation, delivered 14/3/21.

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