Advanced materials and battery technology: powering the future

Frazer-Nash's Steve Merritt explores some of the opportunities that new battery technologies could offer, as we work towards achieving Net Zero by 2050.

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Frazer-Nash recently responded to a call for evidence from the Department for Business, Energy and Industrial Strategy (BEIS) on the UK's position in relation to advanced materials and battery technology. In this white paper, Steve Merritt explores some of the challenges faced, and the opportunities that new battery technologies could offer as we work towards achieving Net Zero by 2050.

The road to reach Net Zero by 2050 is a winding one, with challenges at every mile marker – of recyclability, of scarcity and energy demand, and of industrial decarbonisation. Batteries will be vital in decarbonation, particularly of the transport sector, with innovations in a range of technologies necessary for different vehicle types. So, what are the challenges we face in developing these technologies, and what steps will we need to take to overcome them and to turn the Net Zero single track road into a fast-moving motorway?

Within transport, there are a number of technical challenges faced in developing battery technologies. While small vehicles with short travel distances and cargo weights, such as cars and light goods vehicles (LGVs), are easier to electrify, for vehicles with longer range demands and heavier loads, such as heavy goods vehicles (HGVs), current battery technology is not feasible due to their weight and recharge times.

Economically too, there are challenges to be overcome. The British car manufacturing industry is huge: 81% of vehicles made in Britain are exported. In 2019, these exports totalled £48 billion, 11% of the UK's total exported goods. With legislation, to be introduced from 2030, meaning that no new petrol or diesel cars will be legally allowed to be sold within the UK.

For the UK automotive market to remain charged during this transition, we must continue to invest in and research advanced battery technologies, so that batteries are produced in greater capacities. But to protect the environment, the materials for these batteries must be more sustainably acquired.

Scarcity of material resources is one of the critical challenges faced in developing new battery technologies. The goal to reach Net Zero by 2050 is reinforcing a drive for a the 'refurbish, reuse and recycle' approach to battery manufacturing. Currently lithium ion (Li-ion) batteries, with graphitic anodes, are the gold standard, used in products ranging from clocks to cars. However, graphite possesses a high carbon footprint, requiring mining, beneficiation, purification, and processing, with one ton of natural graphite anode material emitting 5.3 tons of carbon dioxide (tCO_2).

Three potential alternatives are under investigation, which could help reduce this high carbon footprint. Firstly, there have been recent breakthroughs in the production of 'green' synthetic graphite. Secondly, metal oxide and metal oxide nanocomposite materials are also being explored, for their potential as an alternative to graphitic anodes. Metal oxide nanocomposite anodes could support new advanced battery technologies, helping to ensure battery stability by moderating volume change during charge/discharge cycles. While there are challenges to overcome to develop these materials commercially, we believe the opportunity to explore the development of the next generation of anode materials is one that should be embraced.

The third technology, currently being developed under the Faraday Battery Challenge Project run by the Faraday Institution, uses a material with which everyone is familiar – salt.

Sodium-ion batteries (NaB) could offer a promising alternative to exclusively using lithium and could help tackle the problem of material scarcity. Sodium is a safe and earth-abundant resource and a by-product of the desalination process, allowing for synergistic industries to be developed in its delivery, a key component in reaching Net Zero.

A review of the status of NaB, from 2021, identified that they are still currently at the stage where they are suitable candidates for stationary battery applications only, and will require further research and development. As such, LiB will still be necessary to power the electric car market needs of 2030.

With the entire removal of graphite from anode battery technology not yet feasible, the opportunity to invest in UK green synthetic graphite production centres should be grasped, to reduce the carbon footprint of the batteries.

Three options – but rather than choosing one to pursue, we need to develop these technologies synergistically, to be able to answer the challenges currently facing batteries and ensure we can meet the increasing energy storage demands needed today.

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We must develop a portfolio of battery materials that enable us to:

- Reduce our dependency on a limited pool of resources, and reduce the environmental impact that results from acquiring these resources
- Better utilise existing industry: sodium for NaB, for example, may be acquired from desalination plants, which would reduce the environmental impact of desalination
- Develop new industry – investing in synthetic graphite creation in the UK could generate a new marketable product for the growing electric vehicle industry and add to the £48 billion in car exports we see today.

The UK is already taking massive steps to ensure we stay at the forefront of battery research, It is essential to ensure that the solutions of today are not the problems of tomorrow. By taking the opportunity to develop a suite of materials, we will be able to diversify our options, reduce demand and reliability on a singular material, and include life cycle assessments and decommissioning approaches for these materials that could help power the way for future generations.