Powering up the UK's battery industry, September 2023

Annexes

Annex 1: Rules of Origin and the UK car industry

Rules of Origin (RoO) refer to the national source of a product or good. Under the Trade and Cooperation Agreement signed by the UK and EU, RoO are applied to electric vehicles (EVs) from 2024. If these requirements are not met, a 10 per cent tariff will be applied to traded EVs, driving up prices. RoO are designed to protect domestic and European industries from competition from abroad by incentivising the use of locally manufactured or assembled materials.

RoO for cars traded between the UK and EU come into force in 2024 and increase in 2027, from where they will be maintained.

Year	Percentage of EV to be derived in EU or UK	Percentage of battery to be derived in EU or UK	Percentage of battery cell to be derived in EU or UK
2024	45 per cent	60 per cent	50 per cent
2027	55 per cent	70 per cent	65 per cent

Due to the relative lack of UK and EU EV manufacturing, RoO will likely up prices for UK and EU made vehicles if the production of EVs and battery parts is not scaled up. This will set them at a competitive disadvantage to cheaper Chinese vehicles, threatening the commercial viability of UK or European brands.

To meet the RoO target, the UK will need a domestic source of cathode active materials (CAM). CAMs makes up around 40 to 45 per cent of a battery's value (for NMC chemistries, the most common form of lithium-ion battery in European cars). A wider shortage of CAM manufacturing capacity across the UK and EU means that in 2027, it is projected that around 25 per cent of CAM for batteries made in the UK and EU will still have to be met by imports. This could see 25 per cent of cars traded between the UK and EU subject to tariffs, increasing the price of EVs traded across the EU border. [1] [2]

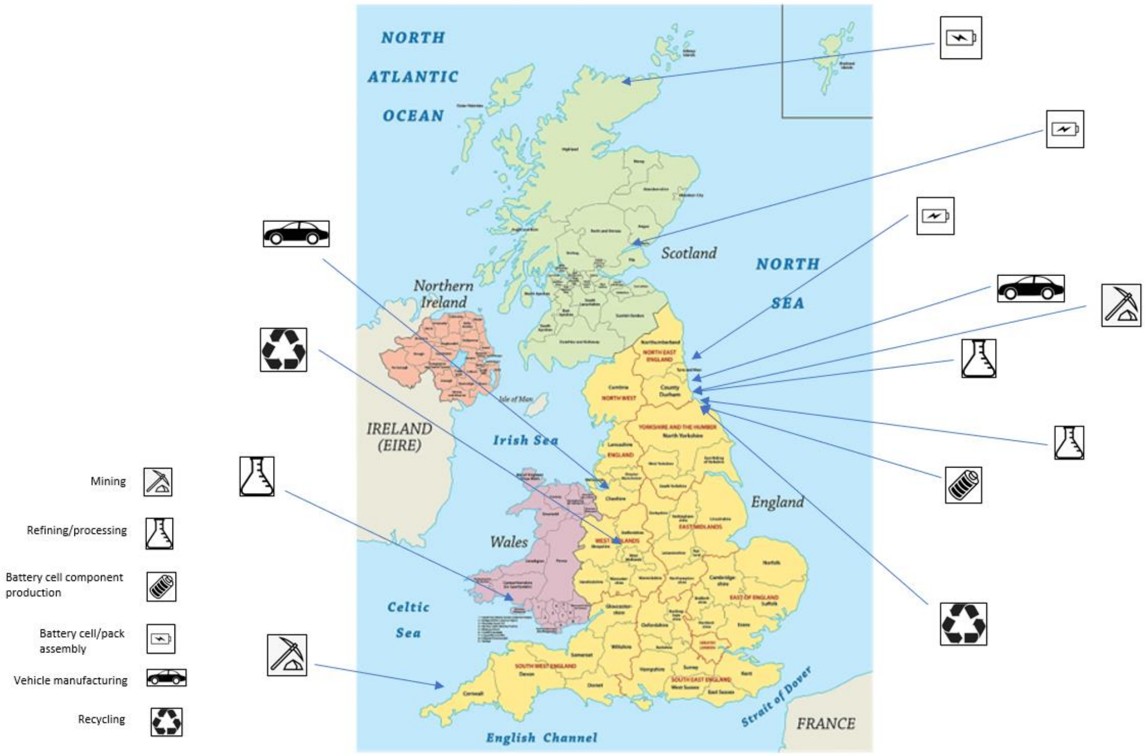
To mitigate this, the UK should look to develop all parts of the supply chain beyond the gigafactory, including midstream CAM manufacturing.

Annex 2: The UK’s strategic advantage across the battery supply chain

Summary of the UK's advantages across the supply chain:

<table>
<tr><th>Stage in the supply chain</th><th colspan="2">UK advantages across the supply chain</th></tr>
<tr><td>Mining</td><td>Lithium deposits in the south west and north east of England
Strong social and environmental credentials</td><td rowspan="6">Centres of research excellence and academic institutions specialising in battery innovation and R&D
Access to renewable energy enabling offer of low carbon product and potentially in future lower cost power
Comparable labour costs with EU counterparts, including Germany
High environmental and social standards</td></tr>
<tr><td>Material Refining</td><td>Projected highest lithium refining capacity in Europe [3]
Historical chemicals expertise and manufacturing
Industrial clusters with potential for carbon capture and storage (CCS) and hydrogen, which can be used in refining processes</td></tr>
<tr><td>Battery cell component production</td><td>Electrolyte plant in Tees Valley (electrolytes, along with cathodes and anodes, form a battery cell)
R&D to improve current lithium-ion cathode chemistries and develop battery chemistries beyond lithium-ion through The Faraday Battery challenge
Specialism in producing niche and premium vehicles where advancements in cathode chemistries are most likely to appear first</td></tr>
<tr><td>Battery cell/pack assembly</td><td>Low embodied carbon batteries</td></tr>
<tr><td>Vehicle manufacturing</td><td>Long history of automotive manufacturing
Niche automotive manufacturing, including luxury and premium brands</td></tr>
<tr><td>End of Life</td><td>Chemicals expertise and manufacturing
R&D in new recycling processes through the Faraday Institution</td></tr>
</table>

Annex 3: Regional advantages in the battery supply chain



Much of the activity underway in the UK is concentrated around the Tees Valley industrial cluster near the Envision AESC plant. This cluster is contributing to one of the highest volumes of refined lithium in Europe.[4] Two further lithium refineries are planned alongside a battery recycling plant, which intends to produce cathode active materials (CAM) from its recycled materials to feed back into the batteries produced in Sunderland. The region has access to cheap offshore wind and carbon capture and storage in the North Sea, and refineries and recycling companies can take advantage of the local chemical industry.

Annex 4: Battery chemistries

Lithium-ion batteries are the 'petrol tanks' of EVs all over the world. While research into alternatives such as sodium-ion batteries is being carried out, no alternative is yet ready to challenge their supremacy.

However, not all Lithium-ion batteries are the same. There are two main types which are differentiated by the chemistries used in their cathodes:

- nickel manganese cobalt (NMC) and;
- lithium iron phosphate (LFP).

The global balance between these battery types has shifted over time and specific manufacturers tend to favour specific chemistries.

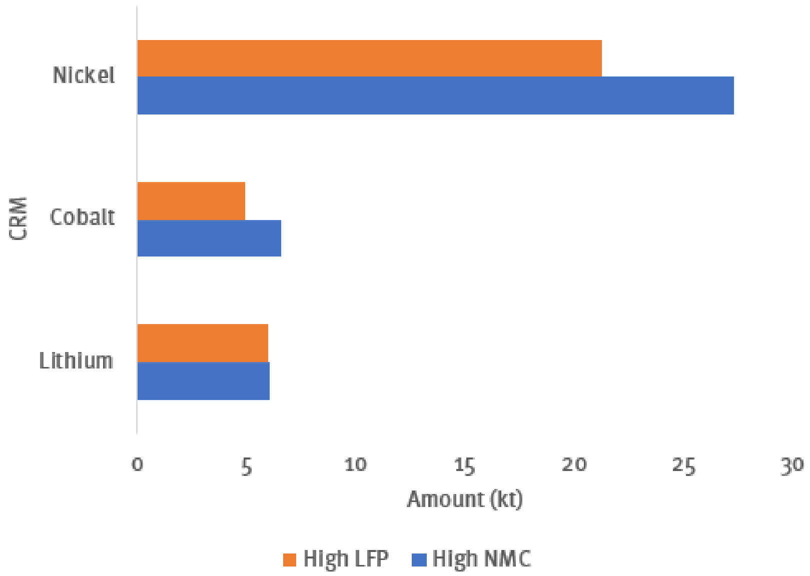
The long term trend has been for manufacturers to move towards NMC batteries but LFP has made a recent resurgence in the global market, largely due to surging nickel prices and the expiry of LFP patents in China.[5] Various car manufacturers, including Tesla and Mercedes, have announced their intention to use LFP batteries.[6]

Each chemistry has different characteristics. For example, a major advantage of NMC batteries is their higher energy density, making it easier to produce vehicles with long ranges. LFP batteries, on the other hand, tend to last longer and are less likely to catch fire.[7]

Green Alliance has produced analysis estimating the amount of lithium, nickel and cobalt the UK automotive sector will require per year in 2030 under two scenarios. Firstly, assuming a continued focus on NMC, and secondly, with a switch to 25 per cent LFP production.

Figure 3 demonstrates that moving towards LFP reduces nickel and cobalt demand but has little impact on the amount of lithium required. While reducing CRM demand would be an important step, a focus on LFP chemistries comes with its own complications. It could see increased demand for phosphorous, which is currently used in fertilizer, and it is difficult to recycle.[8]

CRM demand in 2030:



The difficulty of recycling EV batteries

A variety of factors make EV batteries difficult to recycle. Differences in battery chemistries and a lack of labelling means recyclers don't know the chemical makeup of what they receive. Battery packs are assembled in different ways dependent on the manufacturer, ranging from cylindrical packs resembling larger version of consumer batteries, to stacked square packs. [9] The use of glues and welds could be replaced by nuts and bolts to make disassembly safer and easier. This could be incentivised by the introduction of extended producer responsibility for electric vehicle batteries.

The possibility, and profitability, of recycling batteries is dependent on chemistries. Chemistries containing high nickel and cobalt are more financially viable to recycle using current methods. LFP does not include either of these materials and may only be financially viable through direct recycling. [10] This involves restoring a battery down into cell components, like CAM, rather than individual materials. [11] It is in research and development stages and is not yet commercially viable, so LFP is currently better suited to reuse in stationery storage applications.

Annex 5: the global supply of CRMs

CRM type	Where are global reserves?[12]	Geopolitical Risks
Lithium	• Chile (9,300kt)[13] • Australia (6,200kt) • Argentina (2,700kt)	Although lithium is found predominantly in Australia and South America, China's domination of lithium refining could hinder access.
Nickel	• Australia (21,000kt) • Russia (7,500kt) • Canada (2,200kt)	Despite Indonesia being the largest producer of nickel, battery grade nickel is mainly produced in Russia, Canda and Australia. Small amounts are also found in Finland. Reliance on Russia for battery grade nickel has already had an impact on nickel prices.[14]
Cobalt	• DRC (4,000kt) • Australia (1,500kt) • Indonesia (600kt)	Cobalt production is highly concentrated in the DRC, and 70 per cent of cobalt reserves are located in corrupt or very corrupt countries.[15]
Manganese	• South Africa (640kt) • Australia (270kt) • Brazil (270kt)	Although manganese resources are largely found outside of China, China refines 97 per cent of manganese sulphate with few refining projects outside of China.[16]
Graphite (natural)[17]	• Turkey (90,000kt) • Brazil (74,000kt) • Madagascar (26,000kt)	Graphite extraction is highly concentrated in China and 100 per cent of global resources are in countries assessed by Nygaard (2022) as being corrupt or very corrupt. [18]

Endnotes

[1] Business and Trade committee, 2023, 'Batteries for electric vehicle manufacturing', Oral evidence transcript
[2] Advanced Propulsion Centre, 2023, *Q1 2023 Automotive industry demand forecast*
[3] Transport and Environment, 2023, *A European response to US IRA: how Europe can use its soft and financial powers to build a successful electric vehicle value chain*
[4] Ibid
[5] International Energy Agency (IEA), 2022, *Global EV Outlook 2022*
[6] See for example: *Electrive*, 28th October 2021, 'Daimler to use LFP cells from 2024'; *Electrek*, 22nd April 2022, 'Tesla is already using cobalt-free LFP batteries in half of its new cars produced'
[7] IEA, 2022, op cit
[8] B Spears, 2022, 'Concerns about global phosphorous demand for lithium iron phosphate batteries in the light electric vehicle sector', *Communications materials*
[9] University of Birmingham, 2021, *Securing technology critical metals for Britain: ensuring the United Kingdoms supply of strategic elements and critical materials for a clean future*
[10] L Lander, 2021, 'Financial viability of electric vehicle lithium-ion battery recycling', *iScience*, 24

[11] Z Nianj, 2022, ‘Recycling and Upcycling Spent LIB Cathodes: A Comprehensive Review’, *Electrochemical Energy Reviews*, Vol 5(33)
[12] Global reserves are limited as a means of assessing critical mineral production as it cannot demonstrate the ability to scale up production, nor demonstrate what represents the UKs fair share of access to materials Yet they do provide an indication of the amount of available global resources outside of China that the UK could seek sources from, as well as the scale of the geographical concentration of minerals.
[13] Global mineral reserves are taken from: US geological survey, 2023, *Mineral commodities summaries 2023*
[14] A Nygaard, 2022, ‘The geopolitical risk and strategic uncertainty of green growth after the Ukraine invasion: how the circular economy can decrease the market power of and resource dependency on critical minerals’, *Circular economy and sustainability*
[15] Ibid
[16] International Energy Agency, 2023, *Critical Minerals Market review 2023*
[17] Natural graphite reserves are presented here, but in order to make anodes, synthetic graphite can also be used.
[18] A Nygaard, 2022, op cit