Position Statement

Recovering the critical raw materials in batteries

September 2022

Critical raw materials (CRMs) are materials that are of strategic importance to an economy and that have a high risk linked to their supply and cannot be substituted easily for other materials.[1] CRMs are vital to the healthcare, aerospace and consumer electronics sector and find significant use in information and communications technologies. Crucially, CRMs are also at the heart of most of the technologies that will enable us to cut our emissions and decarbonise our economies.[2]

Materials vital for clean energy technologies include the rare earth metals dysprosium and neodymium in the permanent magnets of wind turbine generators; gallium, indium and tellurium as silicon dopants, conductive layers and semiconductors across a range of photovoltaic technologies; and lithium, graphite and cobalt in energy storage solutions such as the lithium-ion cells used in electric vehicle (EV) batteries.[2]

Our asks in brief

1. Build and invest in UK battery collection and recycling infrastructure to enable the recovery of CRMs from secondary sources. This should include the mapping and tracking of CRM streams and regular assessment of the criticality of raw materials.
2. Incentivise design for battery disassembly and CRM recovery to allow for safe, efficient, and specific end-of-life management. This should be complemented by efforts to foster engagement between academic research and industry to support development of more sustainable battery designs.
3. Update the UK legal framework governing end-of-life vehicles and batteries to support greater circularity of valuable resources, and ensure harmonisation with new EU batteries regulation to help the UK sector comply across markets.

Why do we need to recover CRMs?

Over the coming decades, widespread deployment of energy storage systems and electrification of transport[3, 4] will lead to a dramatic rise in demand for CRMs, putting substantial pressure on the supply side.[2,5] This increase is anticipated in both absolute quantities of material and the relative proportion required by low-carbon development. The International Energy Agency estimates that, to meet current climate pledges, lithium demand will see at least a fourfold increase by 2030, with the proportion of demand from clean energy rising from about 50% to 80%.[5] Whilst nickel is not currently regarded as a CRM,[1] the disruption to supply from Russia due to the invasion of Ukraine in February 2022 led to a price spike and the temporary suspension of trading of nickel on the London Metal Exchange. Prices have stabilised but at approximately double the level of those in 2021, highlighting the vulnerability of current supply chains.[6]

Developing new batteries that are less dependent on CRMs is of critical importance. As is the case with the materials found in electric and electronic equipment,[7] greater recovery of CRMs from batteries that have come to the end of their useful lives is equally important and will help meet this increased demand, reduce reliance on primary extraction of these materials, reduce price volatility, reduce embodied energy of second-life products, and cut waste. In turn, limiting extraction of virgin CRMs will also reduce the energy requirements and environmental impacts associated with mining and refining materials, by orders of magnitude in many cases.[8]

By establishing a Critical Minerals Intelligence Centre[9] and Critical Minerals Expert Committee[10], the UK government has taken an important step towards understanding the challenges we face in this country in relation to CRMs. Building on this momentum, we now need enabling policies and legislation that are designed to tackle some of the specific issues surrounding the recovery of the CRMs in batteries.

How do we get there?

Moving towards a circular economy in which CRMs recovered from end-of-life (EOL) batteries become inputs to new, refurbished or remanufactured products relies on a range of enablers. Research from the Faraday Institution estimates that the UK electric vehicle fleet will be generating 16,500 tonnes of EOL battery packs by 2028, with amounts continuing to rise from this point.[11] As a result, battery manufacturing not only has to keep up with increased demand for batteries as the electric vehicle market grows but also be able to replace battery packs as they reach EOL, adding further stress on CRM supplies. Enabling policies should be put in place before these large volumes of waste batteries become a problem, or the CRMs within them will be lost from the economy.

Firstly, efficient collection and recycling of EV batteries hinges on a dedicated and sustainable infrastructure and recycling processes that can be adapted and scaled up as battery chemistries evolve and ever greater numbers of EVs reach EOL.

At present, the UK lacks a collection mechanism for EV batteries and industrial-scale recycling facilities specifically designed to recover CRMs from these batteries in a safe and efficient way.[12] As a result, most EV batteries coming to the end of their lives are either exported and/or the CRMs contained within them are lost to landfill.[13] Government support will likely be required to establish this capability before commercially viable quantities of battery packs are available.

Secondly, we need to have a comprehensive understanding of the stocks and flows of CRMs at the global and national level to improve governance of these valuable resources, optimise our approaches for their recovery, and identify areas for industrial symbiosis. Currently, there is no CRM tracking system available in the UK, it is difficult to identify CRMs within products due to absent or inconsistent labelling, and battery chemistries are not necessarily fully disclosed by manufacturers, in part to protect their commercial interests. This lack of clarity on the identity of materials contained within EOL batteries at the point of collection impedes safe and efficient recovery of CRMs, inevitably resulting in significant losses of these resources in the largely non-specific pyro- or hydrometallurgical recycling processes that are currently the industry standard.[14]

In addition, the Trade and Cooperation Agreement (TCA) between the UK and the EU[15] stipulates that from 2024 onwards UK automotive manufacturers who seek to export electric or hybrid vehicles to the EU market on a tariff- and quota-free basis need to ensure that an increasing proportion of the active materials contained within their vehicles' batteries are sourced locally. The UK currently lacks the infrastructure to meet these rules of origin at scale, both in terms of mining virgin CRMs domestically and in terms of sourcing secondary CRMs recovered through recycling.

Thirdly, batteries can be designed to facilitate safe disassembly as well as efficient and specific recovery of CRMs. The present EV battery market is diverse and constantly evolving, with many different chemistries in existence and configurations of how cells are organised within battery packs varying by manufacturer and vehicle model.[5,16,17,18] In addition, typical adhesives used at battery pack and module level hinder cell separation, cells are often difficult to open, and active materials that contain CRMs are glued irreversibly to other battery components.[19] Whilst the current EU WEEE Directive requires that batteries must be easily recoverable from products containing them, the Directive on Ecodesign and Energy Labelling explicitly excludes means of transport from its scope.[12] The introduction of producer take-back legislation (as part of individual extended producer responsibility requirements) may therefore be an effective way incentivise such design for recovery.[20]

Finally, an enabling legislative environment needs to incentivise and support the domestic recycling sector as well as EV manufacturers, battery producers and their supply chains to prepare for responsible management of retired EV batteries.[11] The present legislations governing EOL vehicles and batteries in the EU – the UK's biggest export market for vehicles – and in the UK are outdated and do not account for the specific challenges of the rapid growth of the EV market and the associated waste streams that will become dominant in the coming decades.[20,21] Efforts are underway in the EU to update the current legislative framework[22] and the UK's Department for Environment, Food and Rural Affairs (Defra) has made a commitment to bring domestic battery regulation up to date as well.[23]

What is the Royal Society of Chemistry asking for?

To enable a circular economy for the materials used in EV batteries and other energy storage systems, the Royal Society of Chemistry is asking the UK government to take action in three areas:

1. **UK battery recycling infrastructure**
    a. Invest in a sustainable domestic EV battery collection and recycling infrastructure that can satisfy a significant proportion of our future demand for CRMs from secondary, and therefore lower-impact, sources
    b. Ensure that CRM streams are covered in the National Materials Datahub so that CRM use and reuse can be mapped and tracked
    c. Conduct regular assessments of the criticality of raw materials across all sectors of the domestic economy, including the EV and energy storage industry
    d. Support the EV and battery manufacturing sector in the UK to encourage use of secondary CRMs, including to comply with the EU-UK TCA rules of origin for battery materials
    e. Incentivise closer collaboration between academia and industry to support the development and deployment of economically viable CRM recovery technologies
2. **Design for battery disassembly and CRM recovery**
    a. Create incentives for more harmonised battery designs that allow for safe, efficient and specific end-of-life management. Design elements could include:
        - Clear labelling of battery packs with sufficiently detailed information to enable easy sorting, safe disassembly and efficient processing of different battery configurations and chemistries
        - Greater standardisation of battery pack fixings and configurations to allow for more efficient processing

- Minimal use of adhesives at battery pack and module level to support cell separation
- Cells that are easy to disassemble to components
- Easily debondable or no adhesives to enable efficient separation of active materials from electrode current collectors

b. Continue to foster engagement between academic research and industry to support development of more sustainable battery designs that support the competitiveness of the UK electric vehicle supply chain through, for instance, the UK Battery Industrialisation Centre.

3. Legislative framework

a. Update the end-of-life vehicle and battery legislation in the whole of the UK to support greater circularity of the valuable resources used in batteries and to reflect the new dynamics created by the emerging EV market

b. Harmonise domestic legislation with the new EU batteries regulation to help the UK sector comply with both frameworks

c. Incentivise ecodesign for efficient and simple deconstruction, reuse and recovery through regulation.

Contact

The Royal Society of Chemistry would be happy to discuss any of the issues raised in this position statement in more detail. Any questions should be directed to policy@rsc.org.

About us

With about 50,000 members in over 100 countries and a knowledge business that spans the globe, the Royal Society of Chemistry is the UK's professional body for chemical scientists, supporting and representing our members and bringing together chemical scientists from all over the world. Our members include those working in large multinational companies and small to medium enterprises, researchers and students in universities, teachers and regulators.

There are numerous ways in which chemical scientists are working towards a sustainable, clean and healthy planet, and this position statement is part of The Royal Society of Chemistry's contribution to do so. We developed this statement drawing on evidence from chemical scientists and other experts working on these issues, and we are grateful to all the individuals who provided their expert input into its development and scientific review. We owe special thanks to Professor Magda Titirici (Imperial College London), Professor Matthew Davies (Swansea University), Dr Jyoti Ahuja (Birmingham University), Professor Andy Abbott (Leicester University), Professor Robert Lee (Birmingham University) and Dr Louis Dawson (Birmingham University).

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