

Business and Trade Sub-Committee on Economic Security, Arms and Export Controls

Oral evidence: Critical Minerals, HC 1795

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Members present: Liam Byrne (Chair); Dan Aldridge; John Cooper; Sarah Edwards; Justin Madders; Charlie Maynard.

Questions 31 - 52

Witnesses

- Caspar Rawles, Chief Operating Officer, Benchmark Mineral Intelligence;
- Professor Martin Freer, Chief Executive Officer, The Faraday Institution;
- Pranesh Narayanan, Senior Research Fellow, Institute for Public Policy Research.

Examination of witnesses

Witnesses: Caspar Rawles, Professor Martin Freer and Pranesh Narayanan.

Q31 **Chair:** Welcome back to the Sub-Committee on Economic Security's inquiry into critical minerals. Thank you very much to our second panel for bearing with us while we voted and performed our democratic duty. Thank you for joining us to give evidence today. Martin Freer, perhaps you could kick off and tell us a little bit about how you think demand for different critical minerals is going to change over the years to come.

Professor Freer: I will introduce myself so you know the context. I am Martin Freer, chief exec of the Faraday Institution. Faraday looks after the early-stage innovation in the battery sector, so I am going to talk mainly about critical minerals that are associated with that really important sector for the UK, for all sorts of reasons.

If you look at how things are changing over the next decade, we are on an S-curve. That S-curve is driven by the transition that we are going through with electric vehicles, obviously, but also what is happening around the energy sector. Lithium ion is used in grid storage, which is short-duration storage, and we need technologies for longer-duration storage. Defence is increasingly driven by improvements in technology, and electrification is penetrating that sector, most obviously. In the future, there will be aviation. In the next 10 years, we are going to see ourselves moving from the bottom to the top of this S-curve.

If one was to measure the need for critical minerals, so if we were to take the UK on that journey and by 2030 we were part of the way up that S-curve, we would be looking at just the UK exploiting something like 40% of the global lithium supply. That is the UK alone. If we think about what batteries are made of, it is a whole series of materials. There is lithium, nickel, cobalt and manganese. Also, bizarrely, there is graphite sitting in those batteries and access to that is supply chain limited. There is huge change in demand that is going to happen.

Q32 **Chair:** We have just heard that the critical minerals assessment that is conducted basically looks at what the economy needs today, rather than colouring that assessment with projections about what the future might hold. You have a reasonably clear view about what is going to happen in particular parts of the economy. What are the critical minerals that you would anticipate coming on to the list in the years to come, or is it simply a case of demand for the current list expanding?

Professor Freer: I am most worried about what is on the list at the moment, because that is the thing that is driving all those sectors. Part of what we do is develop technologies of the future and that will be based around other elements and minerals. Battery technologies will move on.

If you look at the scale of demand that exists in the sectors I described, it is huge. How to benchmark this? If we were to look at gigafactories,



which are taking the raw materials for batteries and processing them into cells, in Europe we have something like 370 gigawatt hours. That may not mean very much, but at the moment, the UK is 4% of that. Over the next few years to 2030, Europe is looking to expand that 370 by another 1,000 gigawatt hours, so the demand for battery manufacturing is larger by a factor of four. The scale of materials' availability right now is really important.

Q33 Chair: We have 34 critical minerals on the list today. Would you anticipate that list growing? Let us say the geopolitics stays as insecure as it is today—take that off the table—would you anticipate a bunch more critical minerals coming on to that list of 34 in the future?

Professor Freer: From our perspective, from the battery sector, the list of critical minerals covers it.

Q34 Chair: Would you therefore be able to estimate the quantum growth in demand for those 34 different minerals based on the demand curves that you see?

Professor Freer: The answer is yes, at the moment.

Q35 Chair: Might you be able to supply that to us?

Professor Freer: Indeed, yes.

Caspar Rawles: I have some of those numbers here, so I can give them today and I can provide more detailed numbers. For the UK specifically, lithium demand today is about 32,000 tonnes. By 2035, we expect that to rise to 157,000 tonnes. For nickel currently—when I say “currently”, this was last year, so 2025—it is 16,000 tonnes, increasing to 114,000 tonnes by 2035. Cobalt was 10,000 tonnes last year, increasing to 42,000 tonnes in 2035. Natural graphite was 23,000 tonnes last year and 114,000 tonnes in 2035. That includes end-use demand, so things such as electric vehicles and energy storage, but also requirements for industrial processes and industrial manufacturing. That would go into batteries made here or other products made here containing those critical minerals.

Q36 Chair: Pranesh, would you add anything to round out the picture?

Pranesh Narayanan: My colleagues would have much more accurate figures than I do. There are 34 critical minerals on the list, but it is clear that some are more important to the UK than others. We are making bets on the battery sector. We are also making bets on wind turbines and the defence sector. All in all, for the elements mentioned, I would probably add the importance of the demand growth around rare earths. Their use in wind turbine manufacturing and defence is going to drive that.

There is a huge uncertainty in how demand is going to play out because of the trajectory of different technologies. As Martin mentioned, innovation drives the chemical make-up of the technologies that we rely on. We could forecast all the demand based on the economy today in



various scenarios. The UK Critical Minerals Intelligence Centre has a range of demand projections based on different energy transition scenarios, but that does not factor in things such as growing demand based on AI and digital technologies or defence technologies.

Q37 Dan Aldridge: Thanks, everybody, for being here. You have talked a bit about the EVs, battery storage and renewable energy infrastructure that are prioritising some of this. Emerging technologies, such as semiconductors, AI hardware and quantum systems, are also coming online and will be increasing the demand for specialist materials. Which emerging technologies are likely to drive the biggest increases in mineral demand, in your opinion?

Pranesh Narayanan: We have not looked a great deal into the other sectors. We have mainly looked at the energy transition and the sectors involved in that. It looks like the main drivers are defence and AI.

Caspar Rawles: We are seeing the new demand that is coming online. Everyone is comfortable with EV and ESS—energy storage systems, so batteries tied to the grid or to behind the meter in people's homes. We are seeing that data centre piece, so obviously the processing compute that is required there, but also the huge amount of copper to manage the big power demand and batteries associated with that. In many cases, not just in the UK but all over the world, the grid is not equipped to deal with some of the power surges that are associated with those massive data centres. They use batteries to manage that when there is peak demand for power at the data centre. That is likely, in terms of volume, to be one of the key drivers outside of those EV, transport and energy storage pieces.

Professor Freer: You picked out some interesting sectors, but I am going to tell you about the battery sector. Part of our role is to think about technologies of the future. We have lithium ion solutions, LFP and NMC at the moment. What is coming into market now is solid-state batteries. They have particular advantages in terms of energy density. Lithium sulphur is coming next. Sulphur is abundant and so you move away from some of the critical mineral sensitivities. Sodium ion is another that has potential for grid storage. Sodium, again, has the advantage that you do not have the critical mineral dependence. Sodium is abundant.

Part of what an innovation programme is doing is looking at how you remove some of these dependencies. Lithium sulphur is really exciting because it gives you really high energy density for aviation defence-type applications. Then there are some really interesting technologies that we need to develop.

One big challenge that we have in the UK is the energy grid. Storage on the energy grid right now is mediated by lithium ion, so whatever you can buy off the shelf, typically from China. In the future, we are going to have a real challenge as we back gas off the grid. How do we manage the intermittency of the grid on longer timescales, so weeks, which lithium



HOUSE OF COMMONS

ion is typically not good for? We are looking at new technologies that would come in there. It is a big market opportunity, but there could be particular critical minerals sensitivities that play in there.

Dan Aldridge: That is fascinating. Thank you.

Q38 Sarah Edwards: We heard a bit in the last panel about where these minerals are coming from. I wanted to probe a bit more about where these gaps and vulnerabilities are going to impact the supply chains of some of the new technologies that we are looking for, so batteries as one example. I wanted to get your views on that and what the mitigations are. I know that the IPPR has done some mapping around this, so perhaps you might like to start and talk about that risk of disruption, then we could talk more about the individual potential items that could be at risk. Perhaps that is one way to start the conversation.

Pranesh Narayanan: Our work looked at many clean technology supply chains, so solar, batteries, critical minerals and steel. Among those technologies, critical minerals are definitely the most challenging in terms of supply chain risks. The concentration of processing in China is, by and large, the biggest risk there, as you would have heard from other panellists, and there are the dependencies that creates for the UK. We analysed the battery sector, so typically that is around battery active materials, which Professor Freer is likely to talk about in much more detail than I am.

Based on our calculations, the UK is largely going to be import-dependent on most critical minerals. It is unlikely that it is going to start ramping up massive amounts of production in graphite, for example, on its own. It is unlikely that there is going to be a huge amount of rare earth materials processing here. We may have some more advanced production of rare earth alloys and such, but the actual materials will have to come from another country. Those are possibly the largest risks. On lithium, on the other hand, if current investments play out, we should be relatively secure.

Q39 Sarah Edwards: Do you look at the future demand in those calculations as well, not just at what we know today? We know that we want to grow those industries and that there will be a greater need, so future supply chain disruption could have a larger knock-on impact to the economy. Is that the way that those predictions are structured?

Pranesh Narayanan: Yes, exactly. Sorry, I do not have the figures off the top of my head, but they are in our report. We looked at the projections that the Faraday Institution produced on EV production to build out our analysis of import dependencies.

Q40 Sarah Edwards: We have here that "a severe, year-long disruption to the UK's top supplier of battery components from 2030 could lose out on 583,000 units of EV production and put up to 90,000 jobs at risk." That is just one example. Did you want to pick up on that, Martin?



Professor Freer: If we think about the journey for battery minerals, lithium comes from Australia and Latin America. Once it has been extracted, where does it go? It all goes off to China. The raw minerals then get refined into what are called cathode active materials, and it is those cathode active materials that are put down on the electrode. At the moment, it is something like 80% to 90% of that supply chain that goes through China.

There are particular risks associated with that. Most obviously, at the moment, China is beginning to assert export controls around what grades of material can be exported. That will mean that, potentially, battery manufacturing in Europe and elsewhere in the world will be constrained. That sensitivity is particularly important.

We have been doing a set of analysis with a policy commission led by Lord Hutton around what it is that the UK needs to do to solve some of these challenges. The first is that you need to think about all the components. Just thinking about critical minerals alone does not solve things. You need to think about an automotive manufacturer, then the battery manufacturing and then the critical minerals and the refinement that feeds into that.

Q41 **Sarah Edwards:** I wanted to ask about items, such as batteries, that are hugely dependent on China, which potentially has a big stronghold on their cost and on the variation or fluctuation of that. It is actively looking at vertical integration, so it has stakes in the critical minerals and the refining, then it has the lithium, the batteries and the end product—we know that BYD has looked at that through its entire operation. How on earth can the UK compete with that scale of an operation?

Professor Freer: We have battery manufacturing. We have some lithium that we could extract, but we are going to be relying on global supply chains. Developing relationships with countries in Latin America, where two thirds of the lithium is, is an obvious place to start—deep relationships with these countries. We need that midstream refining and materials processing.

That is not just we as the UK; Europe needs this. Working in partnership with our partners in Europe to establish refining capability and minerals processing capability within Europe is really important. It is going to require Government intervention there.

Caspar Rawles: I would like to reiterate that the critical gap at the moment in the UK supply chain particularly is the midstream. It is that chemical processing and anode and cathode. A good example is that we produce needle coke here in large quantities at the P66 refinery in Humber. That all goes to China. Even if we wanted to turn that material into anode right now, we would have to send that material to China to bring it back here to then go into our batteries.



The other piece that is important to highlight about the whole supply chain is that it is speciality chemicals and advanced manufacturing. It is not a case of you build the factory or refinery, turn it on and it works. There is a huge amount of IP and knowledge that goes into manufacturing nearly all of the products in this supply chain. It will take a long time from building that plant to gain the experience to reach the qualification standard and high specification requirements across the chemicals and the batteries.

Q42 Sarah Edwards: What is a long time?

Caspar Rawles: Qualification for a lithium chemical can take 12 to 18 months, but you would need to do that for the specific plant in many cases, so you need to build the plant and then qualify with the automotive or cell manufacturer that you are selling to. From turning on the plant, you are not turning out chemicals that will be used by customers on day one. It takes a long time.

The other thing that is important to add is that obviously the UK is not going to be self-sufficient in these minerals. We are a relatively small island. We are quite densely populated. Land is expensive, energy is expensive and it is difficult to achieve. We are relatively wealthy, so we will have a lot of these minerals in products we buy, whether that is EVs, energy storage or people's batteries at home, but we do not have a developed recycling supply chain.

You could bring the recycler, but you are going to need the rest of the value chain to turn those products back into new products to go into our cathode plants and anode plants of the future and the battery plants that we have today. Without that, we are not going to be able to do it. Many other nations are already starting to ban the export of these—the recycled product is called black mass—spent batteries and black mass. They want to keep it within their borders so that they can turn it into these critical minerals that everyone wants and needs.

Q43 Charlie Maynard: Pranesh, I think you are an economist by background. Following on from Caspar's point, we are not going to be able to do this alone. There are lots of efforts: the G7 critical minerals action plan, the Minerals Security Partnership, RESourceEU and Pax Silica; there are various things going on internationally. Ultimately, China is producing this product—and refining and smelting particularly—much more cheaply and at a much larger scale than almost anybody else is. What do you see as a strategy and a plan, not just for the UK but for those, let us say, non-China allies or however you want to frame it? Do you see that ever getting off the ground? What would be the first few steps to try to make that happen?

Pranesh Narayanan: There are lots of overlapping efforts to make some progress on co-operation on critical minerals. Largely, they have been diplomatic efforts with international treaties.



Q44 **Chair:** Are they pointless? That is what we really want to know.

Pranesh Narayanan: Yes. They do not have much to stand on. Instead of thinking about these things as diplomatic projects, they should be thought of as investment projects. There should be a much more concerted effort to form focused partnerships with specific countries—maybe two or three countries that have an interest in a specific supply chain—to bring businesses from each of these areas and Governments around the table and think about what kind of deal structure would work. What specific infrastructure investment project are we trying to deliver to diversify our imports from China?

In the case of critical minerals, a lot of the focus going forward should be on where we could develop new refineries and processing plants outside of China. How could we use the capital that we have in the UK and in other allied countries, such as the EU, to help finance that? Some of that has to be public capital. Left on its own, the market under-invests in resilience. It is not necessarily going to develop the most resilient supply chains without additional public funding.

Q45 **Charlie Maynard:** How much visibility do you have on the EU? The US is doing that thing, and the only other party that perhaps has sufficient scale might be the EU. It has RESourceEU. How much is it doing in terms of working out, “We have a risk in this mineral, this mineral and this mineral. We want to have refining and smelting somewhere, either in the EU or outside the EU, and we are going to put some money behind it”? Is there a granular plan that it has or is developing, or are you not sure?

Pranesh Narayanan: It does not appear to be a granular plan as such, but there are movements around rules of origin for batteries, for example, which try to almost regulate an alternative supply chain. It is still not necessarily putting in place the incentives for these projects to be built around the world. For example, with rare earths, there could be potential for Malaysia to expand its capacity of rare earths processing, but it is quite hard to see how a regulation around the rules of origin, which is a few steps removed from that specific investment, quickly gets you an investment project off the ground.

Q46 **Charlie Maynard:** In the UK Government, in terms of trying to wrangle the cats into some sort of bag, is DBT very active on this, or anybody? It is beyond the scale of the UK, so I am wondering how much the UK is trying to pool.

Pranesh Narayanan: The most obvious effort to point to is the global clean power alliance. The Government are trying to convene many economies that have an interest in clean power and the supply chains within that. Unfortunately, that is very limited in scope. It is tied to the Government’s clean power mission, so its focus is very much on energy infrastructure supply chains. That could be a vehicle for collaboration on cabling and other parts of the supply chain but, when it comes to things like batteries, there are gaps, and so that set-up is not necessarily



working. That needs a layer underneath it that says, "We have these 80-odd countries that have declared their interest through the global clean power alliance. Now can we set up some focused working groups to think through specific investment projects that would help diversify our imports?"

Q47 Chair: We are basically going to need to build syndicates, are we not, to mobilise the finance to build these facilities outside China?

Pranesh Narayanan: For example, going all the way back to the 1950s, the International Energy Agency was set up as an oil stockpile in response to a shock to fossil fuel supplies. We are going to need to rethink, in this new era of supply chains and technologies, what international agencies we need and what capabilities they would need. Ultimately, these partnerships have to come up with new institutions that have genuine powers to do something.

Q48 Charlie Maynard: Martin, switching slightly to your interest in batteries, I was looking at something last night about CATL and BYD, and the \$2 billion or something that they had just announced that they are putting into battery technology, and about the amazing 1,500 km that they had just announced—where is the UK, in terms of tech, when you match us up against the scale of those sorts of companies and the Koreans and the Chinese? What do we have going for us that is actually competitive or could be competitive?

Professor Freer: You need to remember the history of what has happened in the sector. Where did the lithium ion come from?

Charlie Maynard: Yes, I know.

Professor Freer: It came from innovation and a Nobel prize, which was happening in this country around Oxford. We started it all off and the Chinese recognised the opportunity. I was going to come back to your other question. Do not give up on the brilliant companies that we have in the UK. There is really exciting stuff in the minerals processing, cathode active material side of things and recycling. There is some really fabulous innovation. If I look at our programmes, we are state of the art in terms of the next-generation technologies.

Of course, it is quite hard to benchmark exactly what is going on in China, but our belief is that our research, particularly in areas such as lithium sulphur, is well ahead of the international competition. That means that we need to back the development of those sectors to ensure that we stay ahead. You are right: CATL has something like 22,000 researchers. We fund 500 researchers in the UK. They are brilliant people from some of the top universities in the world, but we need to ensure that we are aligning everything so that we stay competitive.

To pick up your other question, we should also be looking at how we work in partnership with the Chinese. They have spent ages refining manufacturing processes. Are there companies that would come and



HOUSE OF COMMONS

invest in the UK? We can learn and then develop the next generations together.

Chair: We should not discount that.

Q49 **John Cooper:** We are talking about what Britain can do, and the Government published a critical minerals strategy in November. There has been some criticism of that, a bit of it from this Committee as well, in that it sets targets but not really a road map for how we are going to achieve that. I wonder what you think about that strategy and whether it does enough to derisk these supply chains. We are hearing how enormously complex these supply chains are.

Leading on from that, we have been touching on what more the Government can do to address the mineral supply risks and strengthen our long-term resilience. Your top three ideas for that would be good. What do you think about the Government strategy currently and what more could we be doing?

Pranesh Narayanan: It is positive that it has genuinely shone a light on the midstream processing issue and that has become a focus of the strategy. The domestic response and building out the domestic supply chain are a lot more developed in that strategy, even if it is not necessarily backed up by enough money. For me, we should pivot more to what we can do with international partners. How can we get together?

Q50 **John Cooper:** You talked about Europe. Do you think that we should have a strategic alliance with Europe in a general sense, or should we be looking to countries such as Canada, for instance, that have supplies? They have a lot of minerals in the ground. Should we be partnering with them? India, for instance, is another huge opportunity, I think.

Pranesh Narayanan: There should be multiple partnerships on a supply chain by supply chain basis. The approach that the Government have currently taken, which is to have these broad agreements with specific countries, is not necessarily working. This would look like Governments coming together, including public agencies such as UK Export Finance and British International Investment from the UK; their equivalents in places such as China; and, to go back to the example of rare earths processing that I used earlier, officials from Malaysia and companies based in Malaysia. The focus of that should be, "What is a specific project that we can all get behind and invest in as quickly as possible?"

Q51 **John Cooper:** Professor, we have a destination in mind. Do we have the road map to get us there, do you think?

Professor Freer: It is important that we have a strategy. We have a number of strategies, do we not? We have a modern industrial strategy, a critical minerals strategy and a battery innovation programme. Government have put quite a lot of money into the battery innovation programme, so £450 million over the next four years.



That is some serious intent, but how do we integrate these things? That is the challenge. How do we ensure that the critical minerals component for batteries that is in the critical minerals strategy is properly integrated into the battery programme? At the moment, because of the sequence of things, you have the battery innovation programme and the critical mineral strategy comes later. I do not think these things are properly integrated. There is a need to bring all this to a single point. It is about leadership, is it not? Somebody in Government needs to own the problem and drive the development of the sector.

Q52 John Cooper: Have you any sense of who that should be? Is there an existing Department? Should it sit with DBT?

Professor Freer: Both strategies sit in DBT, so there is a natural home there. This is such important stuff that it needs to be at, I would have thought, Cabinet level, so that it can be cross-Department and get the proper buy-in of the Prime Minister.

Caspar Rawles: Someone definitely needs to own this problem, because it is a very challenging one. It is not only important for national security; it is important for economic prosperity, and productivity growth is a key focus of this Government.

Some of the challenges that we face are already looked at in that document, such as energy. Energy is the major one. I mentioned graphite and anodes earlier. To turn that synthetic graphite feedstock into graphite, you put it in a furnace at 3,000° for two or three weeks. It is a lot of energy. In the UK, we cannot compete because of the cost.

The other piece, which has already been mentioned, is money—significantly more money. Billions need to be poured into this to make it function and give us a fully functioning supply chain. The piece that the Government need to decide is how much we are willing to support the industry for national security, so there will be support at all costs, and how much we want to put in to drive economic prosperity. There will be different levels of investment and risk that you can take with both of those, but they need to be looked at as individual projects, obviously joined together to create the supply chain.

Chair: Thank you very much indeed. That has been extremely helpful in shaping our thoughts. We are very grateful to you. If you have any further reflections on today's session, please drop us a line. We would be very grateful to receive it. That concludes this panel.