Written evidence submitted by Johnson Matthey

Johnson Matthey (JM) is a British company and a global leader in sustainable technologies, applying cutting-edge science to create solutions with our customers that make a real difference to the world around us. JM is a FTSE 100 company with a 204-year history, employing over 15,000 people in more than 30 countries. JM has a very deep knowledge of the automotive industry, being pioneers and leaders in the emission control area – over one in three cars worldwide contain JM autocatalysts to control their emissions. JM has a growing battery materials business, developing advanced cathode materials for battery cells in hybrid and fully electric vehicles, to enable the vehicles to travel further on a single charge (by increasing the energy density of the cathode materials) and to reduce the time a battery takes to charge. JM believes that Battery Electric Vehicles (BEVs) will play a major role in getting the UK, and the rest of the world, to net zero. BEV-based technologies represent great opportunities for UK plc, but only if the required government commitment and support is forthcoming, and quickly. There are many countries around the world with the ambition to become global leaders in this field, and at the moment the UK is behind in the battery space, with potential to become a competitive player, as discussed in our response below.

- *What contribution could battery electric vehicles make to achieving net zero by 2050?*

The global roll-out of BEVs is critical in enabling the UK and, more broadly, the world, to reach net zero by 2050. BEVs manufactured using, and charged by, renewable electricity will drive massive reductions in the life cycle CO_2 emissions of the automotive sector. Globally, the transportation sector emits around 7.2Gt CO_2 every year during in-use operation (~ 20% of the total energy-related CO_2 emissions[1]), with passenger vehicles accounting for around half of this[2]. Moving to BEVs cuts these in-use emissions dramatically, to levels in line with the carbon intensity of the electricity used to build and charge them.

- *How well is Government policy aligned with high-level commitment for growth of battery electric vehicles to support its net zero ambition?*

Government policy is well aligned with this high-level commitment, since a ban on the sale of new cars and vans with internal combustion engines will come into force in 2035, providing certainty to industry on the timing of the transition. This gives time for the UK car and van fleet to turn over almost completely to zero emission vehicles by 2050. The Government's Energy White Paper[3] states that "we must aim for a fully decarbonised, reliable and low-cost power system by 2050" and says that the UK will have "an overwhelmingly decarbonised power system in the 2030s". Taken together, these parallel targets of having exclusively zero emission cars and vans (which will be predominantly BEVs) and a fully decarbonised power sector, are well aligned with the 2050 net zero target. The government is also supporting the development of charging infrastructure – both by subsidising domestic charging units and public chargepoints, with £1.3bn dedicated to this in the 10 Point Plan.

However, the recent cut to the plug-in car grant from £3,000 to £2,500, and the exclusion of models over £35,000, is a disappointing move at a time when BEVs still cost significantly more than internal combustion engine powered vehicles. A recent study by BNEF[4] suggests that price parity between BEVs and conventional vehicles will occur around 2025-2027, so government needs to be prepared to support consumer purchase of BEVs as we move through the next few years, to ensure the growing momentum required to ensure the 2030 end of the sale of new conventionally powered cars and vans, and the 2035 end of the sale of new hybrid cars and vans with significant zero emission capability mandates can be met.

Government support is needed to ensure the UK can make a success out of manufacturing BEVs; without battery gigafactories in the UK it is likely the UK car industry will leave our shores due both to the post Brexit Rules of Origin on batteries/BEVs and to the difficulty, cost and carbon footprint of shipping batteries made in the EU's battery gigafactories to the UK for installation in cars here – many of which will then be shipped back to the continent. (Currently around 80% of cars made in the UK are exported, of which slightly more than half are exported to the EU). Transitional rules of origin apply for the period from 2021 to 2026, with BEVs needing to have at least 45% UK or EU content, and their batteries needing at least 50% local content from 2024 to 2026 to qualify for tariff free trade. From 2027, the UK can export any number of BEVs (and PHEVs) into the EU market at a zero tariff as long as the BEV has at least 55% UK/EU content and an originating battery pack, with this originating battery pack having either 65% UK/EU content for the cell or 70% for the battery pack.

These Rules of Origin make it imperative that the UK rapidly secures investment in battery gigafactories and electrified supply chains to create a world-leading battery production infrastructure and to maintain our international competitiveness. However, the UK is at risk of falling further behind Europe for battery manufacturing, since the established cell manufacturers have, to date, selected other European countries, e.g., Germany, Sweden, Hungary and Poland for the location of their gigafactories. Battery manufacturing capacity in continental Europe is expected to reach nearly 450 GWh per year by 2030[5]. The UK currently has a 2 GWh per annum plant in Sunderland and Britishvolt has selected Blyth in the North East for a 30+ GWh per annum plant. In addition, it is expected that there will be demand for seven UK-based gigafactories by 2040[5], with the first few needing to come on-line between now and 2030.

Furthermore, batteries are heavy and regulations around cross-border transport are increasing. Batteries are also hazardous to transport over long distances due to their flammability. These factors will push BEV manufacturing to be located relatively close to battery manufacturing, probably in the same country or region. If batteries are made in Europe or Asia, then it is likely that the BEV would be as well. Therefore, building gigafactories in the UK will help to safeguard the future of the UK automotive industry, and will also provide confidence for the UK chemical industry to invest in becoming supply chain partners. Building on this point, the UK has an outstanding chemical industry (and the battery supply chain is predominantly a chemical supply chain), so the UK has the opportunity to become competitive in battery manufacture, but needs to act fast to get these commitments for gigafactories and their associated supply chains.

- *Are the UK supply chain opportunities around supply of batteries and power electronics, machines and drive supply chain clear?*

There are opportunities within the UK for battery supply chains, for instance synthetic graphite, used in the anode, as the UK has direct access to resources from North Sea oil production. However, when considering other critical raw materials for batteries there Is lack of clarity over how to secure Nickel, Cobalt and Lithium. There is obviously the Vale Nickel refinery in South Wales that could support some infrastructure, but to date Vale have no clear ambitions for targeting the battery industry. Other options will require a heavy reliance on other country refining, a large portion being in China.

The Brexit trade deal has supported free trade of batteries to Europe, however these will require UK manufactured batteries to be classified as UK origin, either requiring UK origin raw materials (which don't exist) or sufficient transformation to warrant UK origin status. Longer term, the difficulties will broaden to include end of life batteries. For the UK to continue to produce and sell batteries within the EU post 2030, there is likely to be a requirement of a minimum volume of recycled material

within the battery. Once batteries leave the UK, if they are not put into vehicles sold into the UK, there will be significant 'leakage' of end of life batteries, hampering future recycling within the UK.

- *What natural advantages in terms of access to raw materials, renewable energy supply, technological readiness, IP or other competitive advantage does the UK have to encourage development of battery manufacture in the UK?*

The UK is disadvantaged with respect to several EU countries in the area of raw material access. This is not only limited to the geographical location of Nickel, Cobalt and Lithium deposits, but also the location of refineries. At present the majority of Cobalt and Lithium is refined in China. There are however small pockets throughout Europe (Finland being one of these) that can support a localised supply chain. Finland has access to raw material resources and has the refineries to convert these into battery grade chemicals. This includes companies like Nornickel, Terrafame and Keliber – who between them can provide Nickel, Cobalt and soon Lithium to the industry. There is some Li in Cornwall that could be used to support the UK battery industry, but the more significant supply constraints are expected to be in Nickel and Cobalt. However, in Johnson Matthey the UK has the world's largest secondary refiner of the platinum group metals used, for example, in vehicle exhaust catalysts, so with the right support and policy framework it should be possible for the UK to become a leader in the recycling of battery materials. It is important to note that recycling should be carried out close to where the components using the recycled materials are made and used, to minimise the carbon footprint of recycling. Therefore, there will be a need to carry out large scale recycling in the UK, so it is critical that funding is available to optimise and deploy recycling processes for batteries in the UK, with such recycling ideally co-located with the large facilities making the cathode active materials to supply to the gigafactories.

The UK has a decent position in the supply of renewable energy, with the carbon footprint of power generation being below the average of that across the EU and, e.g., lower than that of Germany (although significantly higher than France and the Nordic states[6]). However, UK electricity prices for industrial users are amongst the highest in Europe[7,8] and this is a real disincentive when trying to attract inward investment in the BEV industry, since cathode active material manufacture and overall cell manufacture are both highly energy intensive processes.

The UK has also set out a clear timeline for the move to zero emission vehicles in the car and light van sector, which gives the private sector confidence to invest. And in terms of IP and idea generation, the Faraday Institution, associated Faraday Battery Challenge, UK Battery Industrialisation Centre and the support of the Automotive Transformation Fund all support the future development of battery-based excellence, innovation and scale-up within the UK. These activities need to be continued and funded on an ongoing and reliable basis to allow for long-term development.

- *What action is needed to support investment and establishment of UK gigafactories?*

There are four principal things the UK needs to do in order to attract gigafactories:

- the cost of electricity for facilities using the vast amounts required for (e.g.) gigafactories and cathode active material (CAM) manufacturing plants needs to be reduced significantly. As discussed above, UK electricity prices for industrial users are amongst the highest in Europe, which is a significant disincentive when trying to attract such electricity-hungry industries to the UK. These high UK electricity prices can also lead indirectly to substantial GHG emissions from gigafactories if they decide to use natural gas rather than the much more expensive electricity,

- develop a more joined-up funding mechanism (and increase funding levels substantially), with this being a package of grants, loans and loan guarantees. This extends to other critical activities within the supply chain such as CAM manufacturing – building a CAM plant in the UK is likely more expensive than e.g. building one in Poland or Hungary, so should also attract support from HMG,

- develop a clear UK strategy on supply chain and raw material access (including the conversion process). The UK does not have its own deposits of Nickel and Cobalt, therefore, to entice new gigafactories to the UK, support for long term security of Nickel and Cobalt is required, which may require investment in mining operations outside the UK. It is also critical to ensure free trade of these products to the UK,

- continue to fund R&D (e.g. Faraday) at the levels of the last 4 years, and continue to support scale up and broader manufacturing activities through e.g. the ATF and Battery Industrialisation Centre - one of the key challenges within gigafactories is the requirement to manufacture cells at high speed and high volume with high quality, and the established cell manufacturers have a strong head start over new players in these critical areas, so the UK needs to catch up.

- *What should the Government do to ensure that gigafactories have a safe, reliable power supply which meets net zero requirements?*

The main requirement here is for a stable, balanced grid with increasing levels of renewables. As outlined above, the intention of the UK government to have an overwhelmingly decarbonised power system in the 2030s fits very well with this objective.

- *What action is needed to support growth of associated power electronics, machines and drive supply chain, including securing supply of raw materials and material processing?*

Securing technology critical metals for the UK[9] is the focus of a Policy Commission that was supported by Johnson Matthey. Whilst a variety of recommendations were made, we believe there are a few of particular strategic importance. Firstly, seeking opportunities to diversify access to primary resources through resource diplomacy. Secondly, the creation of task forces bridging primary and secondary materials, to identify investments that would be required to secure the supply chain for the UK. Finally, consider appropriate governance structures to ensure sustainability and resilience in the supply chain for the critical materials.

- *The Government has announced £1 billion of funding to support the electrification of UK vehicles and their supply chains. Is this figure sufficient? How should it be split between supply chains and gigafactories?*

The £1bn within the ATF is a most welcome, and currently well-funded, scheme to support the critical scale-up activities to build such nascent industries. However, it does need to be seen as a starting point to support a continuing need. It is also important to note that battery gigafactories are very expensive – the Britishvolt/AMTE UK Gigafactory investment is expected to be around £4bn[10] for a 40GWh capacity facility, so around £100m per GWh. As discussed above, the need to develop the supply chain (e.g. CAM manufacture) to support the gigafactories is also critical. In view of the respective costs perhaps a 50/50 split between gigafactories and supply chain would be a good starting point.

- *The £1 billion Net Zero Innovation Portfolio will focus on research into low carbon technologies. What proportion of this funding should be directed towards battery electric vehicle research? What areas should ARIA target in distributing funding for high-risk, high-reward research into battery electric vehicles?*

The Net Zero Innovation Portfolio is focused on 10 priority areas with the stated intent "to accelerate the commercialisation of low-carbon technologies, systems and business models in power, buildings, and industry", which seems to imply that transport is not intended to be part of his fund. Indeed, of the priority areas the one that fits BEVs the best is "energy storage and flexibility", so perhaps some work in the vehicle-to-grid and vehicle-to-home integration, to assist with grid flexibility, could be justified. We note that all the identified priority topics are worthy areas for research and innovation so perhaps £50m in the area of vehicle-to-grid/home could be allocated here.

ARIA is a very welcome addition to the funding landscape, with its exclusive focus on projects with potential to produce a paradigm-shift in an area of science. In the BEV area two of the technologies at the further end of the Faraday focus are solid state and Li-sulfur. We would be inclined to leave these areas in Faraday where work is already ongoing within a supportive and well engaged community. In terms of further-out technologies with the potential for a transformative paradigm shift, moving from Li-ion to Mg-ion or Al-ion batteries would be a good area of focus, since such multivalent ions can transport multiple electrons (rather than the single electron in Li-ion); these alternative technologies have the further advantage than magnesium and aluminium are significantly more abundant than lithium.

A second potential area is the identification of alternative organic electrolytes to enable higher voltage (and therefore higher energy) batteries. This would drive cross-sector engagement between the battery community and the UK's strong pharmaceutical and organic chemistry sectors, where extensive organic chemistry knowledge exists.

- *What steps should be taken to ensure the UK workforce has the necessary skills to staff gigafactories and their supporting supply chains?*

UK universities do great technical work and produce good degree and PhD scientists with the skills to do detailed research, and this needs to be continued by (e.g.) putting in place a long-term funding strategy for critical activities such as those within the Faraday Institution (which will deliver the kind of skills in areas such as electrochemistry which are needed for the continued success of UK industrial R&D), UK Battery Industrialisation Centre and the ATF. Building on this point, a certain critical mass is needed to develop these skill sets. Faraday is a good start, but on its own is too small – the UK needs a broad industrial ecosystem across CAM, gigafactories, and OEMs to build the talent base.

At present, the combined technical, quality systems and hands-on skills around product and process scale up, product prototyping and manufacturing that are ultimately needed in the batteries workforce are more likely to be found in pharmaceutical, formulation, packaging or vehicle manufacture segments in UK, so extra training and adjustment of perceptions is important.

Furthermore, to build a world-class and broad skills base, the UK needs to tap into Asian talent, which is becoming increasingly difficult - perhaps some agreement between the UK and relevant governments on a 'skills corridor' would be a good way forward here.

- *What measures should the Government take to ensure that minerals for battery electric vehicles are sourced in a responsible way?*

Alignment with OECD, ensuring batteries made in or for UK comply with these standards as a minimum. There is also opportunity to make a strategic move, by placing greater significance on recycling batteries in the UK, this would reduce the complexity of responsible sourcing.

- *What action can Government take to support growth of secondary markets to extend lifetime use of EV batteries?*

There needs to an appropriate balance between recycling and second life. At present it is believed the suitable markets for end of life batteries will be saturated relatively quickly. A second life for an EV battery will reduce its carbon footprint, but recycling can also play an important role in reducing the amount of primary material that is required. To put this in perspective, the critical metals that are used to make cathode active materials contribute up to 70% of the carbon footprint of the material. Providing more recycled content will help drive down the carbon footprint of batteries. Overall, therefore, it is vital to model appropriately, to ensure both second life uses are serviced as well as new batteries through recycled content.

- *What steps should be taken to ensure that EV batteries are recycled at the end of their lives and not simply sent to landfill?*

We should look to the latest EU Battery Directive proposal for some guidance on this. Legislation is needed to ensure EV batteries have a second life and are then recycled. The EU has taken it a step further and is legislating the volume of recycled content a new battery must have post 2030. This is not seen by the industry as the most appropriate mechanism. If it is compulsory to recycle end of life batteries and recycling efficiencies are ensured, this should be sufficient to bring down the use of primary material in the future. By the EU insisting the recycled content that must be in a battery, they are potentially enforcing less efficient recycling options - batteries require very pure Ni, Co & Li products, however there are many other uses for these materials, especially Nickel. Therefore, it may be more efficient to recycle end of life batteries to support other industries, which would still have the overall effect of reducing the amount of primary Nickel required to be mined. So the UK should find the right balance – ensuring that batteries must either have a second use or be recycled, while looking to ensure that any legislation considers the most efficient overall recycling option – as outlined above this does not necessarily imply a given, legislated level of recycled battery material in future batteries.

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