Net Zero Review Call for Evidence: IOM3 Submission

The Institute of Materials, Minerals and Mining (IOM3) is a professional engineering, environmental and scientific institution, a registered charity and is governed by a Royal Charter. IOM3 is the global network for the materials cycle, promoting sustainability and greater circularity in the extraction, processing and use of natural resources, with around 15,000 individual members.

Overarching questions

1. How does net zero enable us to meet our economic growth target of 2.5% a year?

The transition to net-zero is essential for UK prosperity, productivity and competitiveness and an opportunity to drive more resource-efficient, resilient and inclusive growth. The economic case for transitioning to net-zero has been widely made by numerous groups of respected experts, bodies, leading organisations and published reports in the UK and globally.

The transition will be enabled through the development of technologies and their supply chains including electric transport, green hydrogen and renewable technologies. It creates opportunities for new industries and new businesses including in next generation lithium-ion batteries, fuel cells and lightweight and sustainable materials.

New job growth will be seen across the economy from construction and manufacturing, to transportation and repair. This includes roles commonly recognised as 'green jobs' as well as many other roles that play an integral role in the transition yet are commonly overlooked. Examples range from mining and mineral processing roles, vital to ensuring a supply of critical minerals for green technologies, to cross-cutting professions such as drivers, software and finance. Job creation across value chains and sectors will help build stable economic growth.

Organisations are recognising that demonstrating their commitment to achieving net-zero (including their supply chains) can help to win work and generate business. What's more, as competition grows for skilled and qualified professionals, companies are recognising the need to ensure their corporate responsibilities meet the expectations of prospective employees in order to attract the best talent. For many individuals, and particularly the younger generation, this commonly includes an increased focus on sustainability and having a positive impact on society.

The UK has a highly skilled workforce available including from the fossil fuel industry (redeployed as these reduce in needs) and young engineers and scientists. These in combination with encouragement for capital to be deployed from the large UK financial base (both domestic and foreign direct investment) can be focused to encourage start-ups, small- and medium-sized enterprises or new divisions of established firms driving additional economic growth.

The UK can lead the way on the global stage and has strong professional support services for industries pushing the highest standards. There are opportunities to sell expertise and strategy overseas through consultancy and subcontracting. In the UK, there are opportunities for re-shoring supply chains which can lead to better environmental practices.

2. What challenges and obstacles have you identified to decarbonisation?

Achieving net-zero will require strong leadership and strategic choices. It needs collaboration across government and across sectors with a joined-up approach and co-ordinated systems. However, activity is commonly too uncoordinated and uneven to deliver the scale and pace of developments needed.

- **Need for a more strategic approach to materials, minerals and mining**

It is well documented that metals and minerals are essential to the transition to a low carbon society. Examples of what will be needed include lithium, graphite and cobalt for electric batteries; rare earth elements for the magnets used in wind turbines; copper and aluminium for electrical wiring and transmission; and steel and concrete for wind turbine towers. Estimates suggest that to have enough of these materials to meet our climate targets by 2050, demand will quadruple by 2040[1] and in some cases global production will need to increase by up to five-fold by 2050[2]. Publication *of Resilience for the Future: The UK's critical minerals strategy* sets out a welcome and much-needed approach to sustainable critical minerals sourcing and resilience which must now be translated through to implementation and delivery.

A wider consideration, however, of materials and resources is needed. The extraction and conversion of materials to goods and services underpins the transition, our economy and our society, and needs to be considered holistically if the UK is going to remain competitive, innovative and wealthy. The transition doesn't rely on individual minerals or elements, but on combinations processed into engineered materials, often through multiple steps, for the unique properties they bestow. This interconnected nature and the vital and wide-ranging role of materials in the transition[3], from developing clean energy technologies to composites for lighter vehicles, and packaging to avoid food waste, requires a more strategic and joined-up approach. This would ensure an effective transition and help the UK capture as much value for its own economy as possible and compete more successfully in global markets.

Exacerbated by the hold on Russian imports, there is uncertainty over which are the best materials to select for new products, considering factors such as security of supply, cost, performance, and environmental impact. For example, in the supply of platinum group metals, the energy transition may result in a change in availability and pricing. It would be useful to have forecasts and scenarios for materials of concern so that product designers can take a long-term view at an early stage of product development.

The foundation industries are vitally important in the UK, contribute significantly to the economy and play an important role in supporting jobs and local communities across the UK. The UK has the opportunity to demonstrate international leadership but due to investment cycles, if key decisions aren't taken and implemented urgently, UK production is at risk. A comprehensive, cohesive and coherent strategy and policy framework, backed by government support, and developed collaboratively with industry that demonstrates a clear decarbonisation pathway and transition to a more circular economy is required. Clarity of direction is needed from government,

[1] https://www.iea.org/reports/the-role-of-critical-minerals-in-clean-energy-transitions
[2] https://www.worldbank.org/en/news/press-release/2020/05/11/mineral-production-to-soar-as-demand-for-clean-energy-increases
[3] https://www.iom3.org/resource/royce-and-iom3-launch-materials-ten-point-plan-for-a-green-industrial-revolution.html

including in relation to wider systems changes to give industry the confidence to make the significant investments necessary to change the technology used.

- **Uncertainty over the format that the energy transition will take**

Although there are some useful roadmaps giving a top-level view of the adoption of hydrogen for instance, there is a lack of clarity about priorities on a more detailed basis. This may make the route businesses are taking to achieve net-zero less efficient. Businesses would benefit from increased information flow on how the market is changing, to help them with more accurate forecasting. A more active direction from government on whether we are achieving short term goals and giving latest updates on trends, would help guide businesses through the changes that are occurring.

- **Technology and data gaps**

To design these new technologies, which need to be scalable at speed, requires innovation deployment to solve challenging problems. It is important to encourage information sharing and dissemination routes, to help engineers and scientists troubleshoot as quickly as possible.

It is currently very difficult to obtain relevant and accurate data on the carbon footprint of materials, parts and processes, despite an increasing demand from industry. There is a need for data on the carbon footprint of raw materials, processes and finished goods especially for non-UK sourced products. An Environmental Product Declaration (EPD) route may be appropriate for life cycle assessment (LCA) with granular data, accurate calculations, transparent results and third party assurance. The overriding need is for honest auditing and standardisation.

- **Upfront costs**

Whilst there are potential initial gains and long-term benefits, it can be difficult for businesses to find the money for upfront costs of transitioning to new systems and processes such as investments in new technology, infrastructure or organisational structures, particularly at a time of increasing costs.

- **Regulation and market incentives**

Current regulation can act as a barrier. For example, lightweight composite materials provide numerous benefits for light weighting vehicles that could facilitate a better take up of electric/fuel cell powered vehicles. However, composites are increasingly restricted due to recycling legislation. Composites can be recycled but this would rely primarily on recycled fibres from one sector such as aerospace becoming a feedstock into composites used for other sectors such as automotive. Support for cross sector initiatives that encourage circularity could provide a kick start for a UK composites recycling industry and support decarbonisation as a whole.

- **Skills – the need for rapid recruitment of scientists and engineers**

The speed that the energy transition must happen is requiring organisations to move fast, and to rapidly grow new areas of their business. Recruitment must correspondingly move fast, and the availability of specialist skills in science and engineering to fulfil this need is a challenge.

There are significant and growing skills gaps in the UK in various materials, minerals and mining sectors that will play vital roles in the transition to net-zero. Whilst the skills base is of high quality, there are significant issues with quantity and diversity. For example, there is growing

demand in the packaging sector for skills to implement the extended producer responsibility policy reforms; the construction sector is facing growing pressures and shortages such as for retrofit designers; and the mining and mineral processing sectors are facing declining provision of higher education and an aging workforce.

As the demand for skills and talent required to drive the transition is increasing, the supply is failing to keep up. Adding to this, some sectors are facing disruptions or steep re-skilling and recruitment forecasts.

Despite strengths and significant knowledge at the research level in the UK, there is a lack of available knowledge about materials that is accessible elsewhere. For example, in construction, the majority of decisions are locked in at the architect and architectural technologist stage, with aspects then engineered out, typically based on price, throughout the chain. Access to the right knowledge and skills at this stage is needed or decisions and opportunities can be missed.

For related opportunities and what more government could do please see responses to questions 3 and 4.

- **Perceptions**

Materials, minerals and mining underpin the transition to a net-zero economy yet some professions, despite playing vital roles, can be perceived as unattractive or undesirable.

Public and media discussions around materials can commonly focus on negative impacts such as emissions and material pollution. A dialogue shift is required to ensure materials are properly valued and recognised for their far-reaching benefits and underpinning role in the transition, our society and the economy.

Mineral extraction and the transition to net-zero are intrinsically linked. Without responsible mining, the UK will not achieve its net-zero target. More open, regular and collaborative dialogue across the UK public, government and media is required about the vital role of mining and mineral processing in the transition and all aspects of daily life.

The damaging impact of incorrectly informed narratives can be wide ranging and significant. Vilifying the mining industry is inconsistent with a desire to increase sustainability and address the climate crisis. To meet the demand for metals and minerals required for the transition whilst improving how we mine, well-trained individuals with sound knowledge of environmental, social and governance (ESG) issues will be needed. Modernising perceptions will play an important role in encouraging participation in the sector and attracting new and diverse talent.

The perceptions of plastics and their negative connotations – that all plastics are bad – can be a significant barrier. Whilst acknowledging that plastics are a carbon intensive industry, they serve vital purposes in modern life and contributing to the transition to net-zero. Accurate information rather than opinion is required to minimise unintended consequences.

Well-designed packaging plays an essential role protecting products, reducing waste and in turn costs, carbon and other resources. It also provides a way of conveying information and can help consumers make informed choices. However, the misuse of packaging and its poor end of life handling and subsequent demonisation (particularly for plastic) can distort decision making about which is the right material, in the right place, at the right time.

Materials science and engineering can be perceived as an unattractive career choice, negatively impacting on recruitment and retention in both industry and academia. There is concern about a cycle developing of knowledge and experience depletion and therefore a decline in interest and advocation, resulting in fewer opportunities and a reduced talent pool, further perpetuating the issue.

Public perception plays a significant role and public engagement is therefore crucial. Organisations such as IOM3 can do some of this (see for example the campaign "Material Challenge: Resourcing Net Zero), but supportive interventions from government are also required.

- **Behaviour change and acceptability of net-zero measures**

To deliver successful change at the pace and scale required, consumer behaviour must be considered. Social, cultural and behavioural factors can act as both barriers to and levers for change. There is substantial evidence showing that deliberative and inclusive public engagement de-risks policy and technological interventions for decarbonisation. An enabling environment that facilitates well-informed decisions is required. This includes providing authentic, accurate information to enable businesses and individuals to make confident choices by identification of low-emissions, resource-efficient and sustainable products. This should incorporate consideration of the transport distances of materials (notably critical raw materials), components and products and repairability information where appropriate.

3. What opportunities are there for new/amended measures to stimulate or facilitate the transition to net zero in a way that is pro-growth and/or pro-business?

- **A strategic approach to materials, minerals and mining**

Materials, minerals and mining underpin every aspect of the transition to net-zero and yet their role and value is continuously under recognised. The technologies we are counting on to reach net-zero rely on materials, minerals, and mining, from lithium and cobalt for batteries, through composites for lighter vehicles or packaging to avoid food waste, to concrete and steel for wind turbines. And the extraction and processing of resources are responsible for a significant proportion of global greenhouse gas emissions.

However, at the moment, activity is too uncoordinated and uneven to deliver the kind of accelerated and focused developments needed. The entire materials supply chain needs to be considered, from raw materials to end-of-life, to maximise the benefit to the UK economy. There needs to be a shift from the current approach, which assumes that materials challenges will be largely overcome by the end use sectors, to a more strategic and holistic view of our future needs. Key enablers need to be nurtured, including:

- Processing and manufacturing capability – to transform materials into economically viable and useable products.
- Design expertise – to identify, deploy and integrate material technology prior to manufacturing.
- Future skills – in resource extraction, material science, design and manufacture to enable the above.

- Appropriate regulatory and standards environment – to allow and encourage the safe, secure, timely and transparent use of new materials technologies.

- **Resource efficiency and the circular economy**

Resource efficiency is a crucial area that presents substantial opportunities[4] for cost-effective decarbonisation[5], yet has historically been often overlooked in climate policy. There are wide-ranging benefits resulting from better valuing and managing our resources from reducing emissions; improving security of supply, improving resilience to price volatility; better environmental protection and supporting jobs.

Embedding circular economy principles and keeping materials, components and products in use at as high quality for as long as possible has the potential to reduce waste, alleviate pressure on primary supply and contribute to emissions reductions. Whilst recycling at the end of life is an important aspect, an efficient circular economy would drive better design and new business models for durability and longevity, resource efficiency and reuse. It would also embed smarter use of materials in the first place, through resource efficiency and well-informed material selection.

A significant benefit of action on resource efficiency is that measures can be implemented quickly. In addition, reducing the demand for primary materials can help lower the overall financial and environmental costs associated with decarbonising industrial production and increase the speed of the transition[6].

- **Energy Efficiency**

Energy efficiency should be a cornerstone of government policy but is continuously overlooked or undervalued. It has the potential to reduce energy use – and thus carbon emissions and expenditure – for households and businesses alike.

The use of more efficient technologies and/or processes to reduce the amount of energy used per unit output is key. The UK currently wastes more than half of the energy produced because of huge inefficiencies in the transmission and distribution network and at the point of use. For instance, of the 29 million homes in the UK, at least 19 million need to be made more climate resilient thus requiring much less energy for the same comfort. Refurbishment of buildings to reduce energy demand is key as 40% of emissions occur during their operation. As we focus on the energy transition, it is important to remember that the cleanest energy is the energy never used.

- **Data**

Accurate and verifiable data and access to this quality data is essential. Without it, materials development and deployment that has the potential to facilitate the transition will be significantly limited. Data informs design choices, guides purchasing decisions and provides a vector for assurance relating to a range of factors such as safety and sustainability. A significant

[4] https://www.theccc.org.uk/wp-content/uploads/2020/12/Sector-summary-Manufacturing-and-construction.pdf
[5] https://green-alliance.org.uk/wp-content/uploads/2021/11/Less_in_more_out.pdf
[6] https://www.resourcepanel.org/reports/resource-efficiency-and-climate-change

challenge faced by materials design engineers is the lack of literature on choosing the correct algorithms for dealing with different types of data that cover various aspects of application of artificial intelligence algorithms to real-world problems. It is important that the carbon footprint of imported products can be measured against domestically produced products so that we do not support inadvertently poor practices overseas.

- **Digitalisation as an enabler**

Digitalisation offers a range of opportunities from enabling a smart and flexible energy system, to improving productivity and performance.

- **UK supply chains**

In order to meet our net-zero targets, humanity will need to use a significantly greater amount of key metals and minerals to build and deploy the necessary low carbon technologies. Whilst there is limited mining in the UK at the moment, this will need to change if we are going to be able to meet our national demand for these critical materials. These industries will create new employment opportunities and contribute to local economies.

UK-based supply chains present opportunities across a range of sectors. For example, in battery electric vehicle sourcing, where a large proportion of the value and embedded energy is in the raw materials, particularly in the battery and power-related components – cell assembly itself is relatively low added-value. Without a localised supply chain, cells are unlikely to meet Rules of Origin thresholds to support exports – for example, 80% of UK-manufactured cars are currently exported. There is therefore a drive to increase the proportion of the supply chain that is based in the UK to capture more of that value.

- **Perceptions**

Rebuilding trust and modernising perceptions of sectors invaluable to the transition will be important. A balanced perspective about sectors such as mining is required and all actors from government and regulators through to schools and universities and to customers, end users and members of the general public will play an important role.

- **Public engagement**

A public engagement strategy from government is required including increased outreach and awareness of the measures and their impact on public life, and more public engagement and raising awareness about the medium term benefits of transitioning to net-zero

4. What more could government do to support businesses, consumers and other actors to decarbonise?

Action towards net-zero must be embedded and integrated properly across the policy landscape.

- **Collaboration and systems approaches**

A systems approach should be taken to decarbonisation. Collaboration and more-joined up thinking is required between the different government teams, units and departments. Cross-sectoral systems approaches would help facilitate the transition effectively, deliver co-benefits and reduce the risk of unintended consequences.

- **A strategic approach to materials, minerals and mining**

The UK critical minerals strategy contains a broad range of potential opportunities and interventions that will need to be turned into action.

More widely, a UK materials strategy is needed to bring a structure and focus to materials sourcing, research, development, testing, and regulation to ensure maximum benefit to the UK economy and society. This should be cross-government and support coordination and collaboration between UK industry and the world-class research and development ecosystem. It would help the UK to develop its materials processing industry so that it can capture as much value for its own economy as possible and compete more successfully in global markets.

A more strategic approach to materials would add value across a range of agendas including solutions for new energy systems; transitioning to renewable feedstocks for composites, polymers and major construction materials; security of supply and leadership in next generation materials; recovery or substitution of materials to increase security of supply; materials and coatings suitable for harsh and extreme environments, such as nuclear and offshore; and increased product life, maximising value retention in the resource.

- **Resource efficiency and the circular economy**

Policies are required that seek to reduce the flow of materials into the economy and maximise the use of the stock that is already there keeping materials in effective use longer with less need for inputs such as energy.

Resource productivity can build the economy's resilience to price volatility, increase resource security and enhance international competitiveness, as well as supporting jobs and reducing pressure on the environment.

The current macroeconomic model, however, does not promote consumption reduction or reward waste prevention sufficiently to drive the behaviour alone, so well-designed government intervention is essential. Cross-government and cross-sectoral systems thinking should be applied to policy making to ensure interventions work effectively and together.

Policy interventions will be required as a suite of complimentary measures to effectively deliver the wide-ranging benefits resulting from better valuing and managing our resources including:

- Measures to reduce consumption, including through influencing consumer behaviour
- Design principles and standards that better support resource productivity, a circular economy and an enabling environment, for example through incentives and standards for rapid innovation and testing of new materials including safety, resilience and public perception as well as updating current design and performance standards with reuse in mind. Improved coherence between standards and legislation across different areas (e.g. chemicals, products and waste) would also help
- Procurement as an overarching driver for government to lead by example and demonstrate what 'good' looks like.
- Complete, accurate and transparent information or as near as is possible including material flow data to support secondary markets (with a multi-sectoral approach) and data to inform decision making. The National Materials Datahub will play a critical role in this. Sector level or industrial hub demonstrators can help, for example in exploring the issues of protection of intellectual property and sensitivity about specific

industrial processes (process 'waste' composition, necessary for it to be useable as an input elsewhere, may tell a competitor a lot about the process being used).
- Support for alternative business models such as service-based or lease systems. Externalities such as resource depletion, carbon emissions and the environmental and social burdens of production are not reflected in the price consumers pay. Were this to be otherwise, the cost of products would likely be such that leasing and service-based models would become far more appealing.
- Policy intervention that addresses the skills aspect (general STEM, apprenticeships, T-levels, funding Further Education, etc.) are necessary. The availability of suitably skilled individuals is geographically uneven and insufficient in many places and government, business and skills providers need to work together to address this.

Policy interventions should embed resource productivity in a strategic and systemic way, moving beyond household waste and end-of-pipe action.

There is a paucity of guidance and information for designers to use to help them understand the potential downstream impacts of their decisions, especially at product end of (first) life. Policy interventions to support best practice and the development of suitable tools to help designers make better choices, such as training, site visit programmes, etc. would be beneficial.

- **Ensure a level playing field and develop markets for low carbon products**

Creating a level playing field – both domestically and globally – is necessary. For example, in the foundation industries this includes addressing energy costs, carbon accounting and location-based access to technology. In the composites sector, the cost of reclaimed carbon fibre, natural fibres and bio resins is rarely lower and often higher than the virgin or synthetic alternative. Without other incentives the market will not fully move in this direction.

- **Financial incentives and support**

Investment support may be required recognising that financial benefits from introducing net-zero actions are likely to arise in the medium to long term and companies may find it difficult to carry a financial burden in the short term. Measures to help reduce transition costs or provide small business subsidies and incentives would help.

Support may be required for retrofitting of ageing UK industrial assets such as chemical plant to reduce fugitive emissions for example by replacing carbon steel, which is susceptible to corrosion, with lightweight corrosion resistant polymeric composites. Similar support should be given for repurposing plant and for new installations.

Financial incentives would support the composites industry to incorporate recycled materials (fibres), natural fibres and bio-based chemicals (resins). Policies to promote UK production of hemp fibres as an alternative to flax would be beneficial.

- **Energy efficiency**

Energy efficiency is an essential tool to reduce emissions, enhance energy security, create jobs and reduce energy bills. The notable policy gap should be urgently filled.

- **Support complete research and development pipelines**

The UK has great strengths at the early levels of research (ie TRL 1-3) but there is a requirement for further understanding, support and investment to scale up and pull through to the middle levels (TRL 4-6). A complete pipeline through the TRLs is required to enable manufacturers to access materials and technology that is mature enough to be implemented into industry without significant risks. This will require additional and strengthened intermediate institutes to accelerate the development of materials through to use. Catapult networks offer substantial benefits and could be further enhanced with greater integration and innovation below TRL 5.

In the UK, greater emphasis and value is often placed on fundamental research that might lead to a new breakthrough rather than research that addresses manufacturing or technology problems. There is excellent research and creative momentum and activity but transitioning from lab to pilot to manufacturing is lacking, with the proof-of-concept stage presenting significant challenges. Funding research with industrial content is not as apparent or successful as it needs to be. In addition, there is a question around whether current metrics such as those used in the peer review process focus too heavily on discovery science and neglect potential exploitation into industry.

A strategic plan and link between industrial and academic strategy is required to address the scattered capability and lack of mechanism to execute strategic intent through to funding. There are positive instances emerging where industry links are more valued such as the UKRI Transforming the Foundation Industries Research and Innovation Hub (TransFIRE), managed by EPSRC, but development of such links requires acceleration and greater attention.

- **Consistent policies and reduced uncertainty**

The transition to net-zero will require significant infrastructure, providing an opportunity for investment and economic growth. Greater certainty, direction and more complete information is required to face the decisions required. Sequenced and consistent policies and incentives are required to provide clarity on responsibilities and confidence for investment.

- **Data, regulation and standards**

It would be helpful if government could create an environment where materials/process decisions can be based on transparent and reliable data to encourage the best materials to be used and allow UK innovations to flourish.

Shared access to public databases created through government could substantially help to address the challenge of access to quality data. An appropriate regulatory and standards environment will be required to allow and encourage the safe, secure, timely and transparent use of new materials technologies. Certification, testing and structural integrity assessment procedures will be required and need to be developed and/or adapted where they are associated with traditionally used materials to enable new materials to be an accessible option. Without quality data and a suitable regulatory and standards environment, there is a significant challenge and barrier to the uptake of new materials, and legacy materials will continue to be chosen in favour due to their perceived lower risk and data availability.

- **Embodied carbon**

Net-zero measures and requirements should include both operational and embodied carbon. Government should support industry initiatives to enable a more consistent approach for example in the construction sector.

- **Skills and perception**

A skills strategy should be developed to enable planning for current and future needs with complimentary timing of skills and job creation. It should address both the incoming and current workforce including recruitment and retention. As skills development can take time, this strategy must be sustained, consistent and long term and include a plan for increasing inclusion, diversity and equality. There is wide-ranging and substantial evidence demonstrating the benefits of a more diverse team and workforce, from increasing innovation through nonlinear novel thinking through to increased productivity and greater effectiveness.

There is a widely acknowledged skills and knowledge continuity gap between an older generation of qualified and competent persons in mine design and mining engineering about to retire and replenishment of those skills from too small a number of new people coming through the system. Policy is needed to promote and develop UK-based mining education and training. The government's UK critical minerals strategy recognises these risks facing the skills base – particularly in mining and mineral processing – and commits to training the next generation of miners, geologists, engineers and beyond. The steps outlined must now be translated through to action including working with UK industry and careers services across the UK to modernise perceptions of mining and to review the UK's skills, education and training along the critical minerals value chain and define a critical minerals skills blueprint, recognising the full breadth of skills we need.

The issues of skills, education and negative perceptions are interlinked. Mining engineering and mineral processing courses must attract students to be successful, however, mining continues to attract severe negative publicity. This needs to be addressed with leadership and support to demonstrate the vital need for raw materials to drive the transition.

Businesses would benefit from an increase in schemes to encourage students to undertake science and engineering, and to then stay in the field once achieved. Perhaps an increase in schemes encouraging businesses to give sponsorship to candidates would increase favourability of these types of courses. There may be a gap between industry communicating what types of vacancies it struggles to fill, and this feeding through into government schemes to support it.

5. Where and in what areas of policy focus could net zero be achieved in a more economically efficient manner?

Demand reduction, behaviour change, and efficiency improvements as previously mentioned in this submission are three key strategies that could enable net-zero to be achieved in a more economically efficient manner.

Government needs to take a cross-sector approach as opposed to a specific sector stance as is currently the case. Examples of where this is necessary would be to create a supply chain for the production of recycled carbon fibres where it is likely that much of the fibres to be recycled would be continuous fibres from aerospace sources but where the resulting products would be short

fibres more suitable for use in automotive applications. Practical technologies exist for such recycling but markets need to be encouraged and incentives provided such that the supply chain is established and a market is created for the recycled products of one sector as the feedstock for another.

The use of artificial intelligence is expected to have a significant impact in accelerating the discovery of materials compared to the traditional trial and error approach. It will also enable businesses to make better choices, for example, to select the best processing parameters for the fabrication process, to optimise the supply chain of manufacturing operations.

See responses to previous questions for further information

6. How should we balance our priorities to maintaining energy security with our commitments to delivering net zero by 2050?

Action to maintain energy security should be aligned with the decarbonisation trajectory. Maintaining energy security and achieving net-zero are intrinsically linked and should not be seen as opposing issues. Significantly improving energy efficiency and scaling up clean energy are key strategies to tackling the interlinked challenges. The economics are clear around the transition to net-zero, and this must remain at the heart of policy-making, including reactive decisions in response to crises.

The focus of energy policy remains skewed towards supply-measures but there is urgent need for equivalent action to reduce demand, reducing emissions and aiding energy security. There remains a policy gap relating to energy efficiency despite having significant emissions reductions potential such as through better insulating homes and reducing the reliance on energy.

In order to maintain energy security while delivering net-zero, reliable, stable low-carbon UK-based power sources are required. More support should be given to emerging solar technologies where the UK is at the forefront of technology now and needs to convert this technology lead into business development. The UK should continue to exploit off-shore wind and grow on-shore wind. It should seek to strengthen the domestic supply chain supporting the wind power industry, including supporting the on-shore production of the materials used in the construction of the turbine blades, towers and electricity generating components.

There are decades of experience building, operating and decommissioning nuclear reactors, with supporting infrastructure, policy and regulatory framework already in place. Following COP26 this solution seems to have been recognised more widely, with renewed support and interest in nuclear from both the public and government.

It is noted that there are large new build reactor projects ongoing, such as Hinkley Point C and Sizewell C. Additionally, further support of the Rolls-Royce small modular reactor (SMR) programme could provide increased energy security as SMRs have the following benefits:

- Location - SMRs offer a small, modular design meaning they can be sited in locations unsuitable for large nuclear power plants. Also, multiple units could be located at the same site providing scalable power to address increasing energy demands.
- Manufacture - Due to its modular design much of an SMR can be manufactured offsite. Being a factory-built repeatable product helps achieve cost savings, higher quality standards and significantly reduces onsite construction activities. This also means SMRs could be

constructed and start operating in approximately 4 years, a much shorter time than traditional bespoke nuclear power plants

- Safety - Due to their lower power output SMRs have a greater inherent safety than large scale reactors. Some have an increased passive safety efficiency for passive cooling. Accidents and unsafe releases of radioactivity to the environment and the public could be eliminated or significantly reduced. This is a key consideration for nuclear power and because SMRs could be built in a factory this enables increased nuclear security and containment efficiency.
- Due to their reduced fuel requirements, refuelling of SMRs could be less frequent than the 1-2 years required by large scale reactors, possibly between 3-7 years. There are some SMR designs which extend this refuelling gap even further.
- Some SMR designs which offer higher temperatures could be used for thermo-chemical hydrogen generation. This hydrogen can then be used for further clean energy production.
- SMRs can be used to complement variable renewable energy (VRE) sources such as wind and solar, SMRs can be coupled to create 'hybrid' energy systems which increase reliability and resilience of the energy system.

Whilst we transition to a low carbon society and push towards reaching net-zero, the growing energy needs of the population and industry must still be met. This means that oil and gas extraction will remain a key part of the picture, albeit reducing while this energy transition is made to renewable sources. It is important that this is done with the highest ESG standards, so where oil and gas produced in the UK is less carbon intensive than that produced elsewhere, it is right that we continue to extract and use it in preference to other, more damaging sources.

7. What export opportunities does the transition to net zero present for the UK economy or UK businesses?

Development of next generation technologies and industries such as advanced batteries and gigafactories, solar industry, hydrogen related products (carbon fibre storage containers) coupled with electric vehicles in general presents enormous export opportunities. Being at the forefront of these deployed technologies enhances the ability to export goods and services such as licensing and consultancy for transitioning traditional businesses to more sustainable and net-zero compliant industry globally.

Questions for businesses

8. What growth benefits/opportunities have you had, or do you envisage having, from the net zero transition?

The net-zero transition has boosted related industries, it has also created a need and a culture for companies to take action themselves or risk losing business. There is now a requirement to share the company's Carbon Reduction Plan during tender processes in many sectors. In order to achieve this, many companies have committed to ambitious science-based targets in line with the Paris accords and COP26 targets. In many cases a 3-step carbon reduction plan has been created and approved to:

1. Become carbon neutral by 2025.
2. Reduce CO_2 emission by 30% by 2030.

3. Reduce CO_2 emissions by 95% by 2050.

Government incentives to duplicate steps such as these by those firms already at the forefront on striving for net-zero would lead to broader business benefits. Plans such as these require initial expenditure, however, the potential business which can be won by demonstrating the company's commitment to sustainability and the potential cost savings themselves in terms of energy and waste, may outweigh this.

In terms of opportunities, nuclear, hydrogen, wind and solar all represent expanding industries which will require equipment qualification, certification, auditing, consultancy support and testing. This describes opportunities which are present across many industrial sectors.

9. What barriers do you face in decarbonising your business and its operations?
10. Looking at the international market in your sector, what green opportunities seem to be nascent or growing
11. What challenges has the net zero transition presented to your business?

See response to question 2

12. What impacts have changing consumer choices/demand had on your business?
13. What impacts have decarbonisation/net zero measures had on your business?
14. What more could be done to support your business and/or sector to decarbonise?
15. Do you foresee a role for your business within an expanded UK supply of heat pumps, energy efficiency, electric vehicles, hydrogen economy or clean power?
16. For clean power industry: what barriers to entry have you found in deploying new plant and technologies?

Electric alternatives to space heating for factories can be expensive

17. How many green jobs do you estimate will be created in your sector by 2030?

The transition to a low carbon, resilient and resource efficient society presents opportunities for job creation and translation across a range of sectors. In a range of industries roles are evolving to be part of the green economy. With some sectors such as composites estimating that a fully green portfolio of products could as much as double the required work force.

Consideration should be given to roles beyond what is considered a 'green job' as many other sector jobs and interrelated sectors will also be integral to the transition. It can be beneficial to look beyond sectors and consider whole value chains and a more holistic approach.

Please see responses to Q2, 3 and 4 for further information

Questions for local government, communities and other organisations delivering net zero locally

18. What are the biggest barriers you face in decarbonising / enabling your communities and areas to decarbonise?
19. What has worked well? Please share examples of any successful place-based net zero projects.
20. How does the planning system affect your efforts to decarbonise?

Freeport status can help to facilitate decarbonisation of industry such as polymers.

21. How can the design of net zero policies, programmes, and funding schemes be improved to make it easier to deliver in your area?

Funding calls that have a very rapid turnaround time can prevent effective applications. Lengthened lead times would facilitate better coordination of a consortium of companies, government and academia.

Net-zero funding directed towards places through the levelling up agenda such as Liverpool and Tees Valley has aided industrial decarbonisation of some sectors. However, multiple scales of funding are required to sustain these locations, attract major industry and build a sustainable skills pipeline.

22. Are there any other implications of net zero or specific decarbonisation projects for your area that the Review should consider?

Questions for academia and innovators

23. How can we ensure that we seize the benefits from future innovation and technologies?

There is an increasing urgency for the development and application of a range of new materials to serve the transition and meet global challenges. The timescales to bring new materials to market need accelerating. Today, implementing new materials often takes more than 20 years – we need to learn from the COVID 19 vaccine experience and develop materials at multiple levels in parallel rather than in sequence and take advantage of new computational tools.

Availability of appropriate and diverse talent will be vital in ensuring we seize the benefits from future innovation and technologies. It is also important to realise the benefits of transferable skills. For example, support for mining education and training envelops a wide range of engineering disciplines, competencies and safety technologies and will have wider benefits for related industries.

Processing and manufacturing capability is required in the UK to transform materials into economically viable and useable products. Significant innovations in efficient batteries, hydrogen energy and carbon capture, conversion, and storage are imperative to achieve net-zero, and an equally important task is to transform these innovations into viable consumer products. The UK's manufacturing industry and supply chains have been hollowed out with the domestic market notably smaller than in other countries.

Many businesses from multinationals to small and medium-sized enterprises regularly choose global locations such as Canada, Germany or Japan for high value late-stage research and development (R&D) activities and technology that is developed in the UK is often acquired by overseas companies. Failing to maximise the benefits from R&D investment and pushing industry overseas, with its associated jobs and economic benefit, reduces the skills pool in the UK and has a negative feedback loop of making the UK less attractive for future investment.

In addition to financing the research activities in net-zero areas, the activities surrounding the rapid deployment to the market and commercialisation should therefore receive significant

attention. One possible solution could be to build dedicated accelerator centres to overcome the barriers of commercialisation for innovations related to net-zero.

Identification of areas where the UK has a technology lead (or is at least up to speed with the rest of the world) and providing investment funds for start-ups and scale up and building domestic champions presents an opportunity, as well as identification of best practice worldwide and introducing it in the UK where possible.

Accurate and verifiable data and access to this quality data is essential. Without it, development and deployment of new materials and technologies will be significantly limited. Data informs design choices, guides purchasing decisions and provides a vector for assurance relating to a range of factors such as safety and sustainability.

Measurement standards are critical to acceleration of innovation. Many emerging technologies lack a robust metrological infrastructure to validate performance claims, benchmark new materials and provide confidence to investors, consumers, regulators and policy makers. Establishment of such capability within the UK would bridge the gap between the laboratory and real-world application, supporting the rollout of low carbon technologies.

A more strategic approach underpinned by collaboration and communication is prudent and needed.

24. Is there a policy idea that will help us reach net zero you think we should consider as part of the review?

Policy interventions that would facilitate the transition to net-zero have been explored throughout this submission including a focus on energy and resource efficiency, a more strategic approach to materials across the value chain, transparent and accurate data and providing support particularly for important but difficult to decarbonise sectors.

The UK should aim to become the leader globally in supporting the generation, storage and curation of environmental data linking products, processes and materials, where the data is transparent accurate and current. A National Environmental Data Champion could see the UK establishing an edge over our competitors by allowing UK industry to demonstrate the environmental credentials of its products with data driving innovation and good practice.

It will be helpful to introduce incentives for the new businesses that introduce and comply with net-zero innovations and provide support in infrastructure or resources. Incentivising the work in this domain and accelerating the commercialisation/adaptation would put the UK economy at the forefront globally. In addition, the government should facilitate the construction of large-scale infrastructure and scale-up and manufacturing sites for new products related to net-zero.