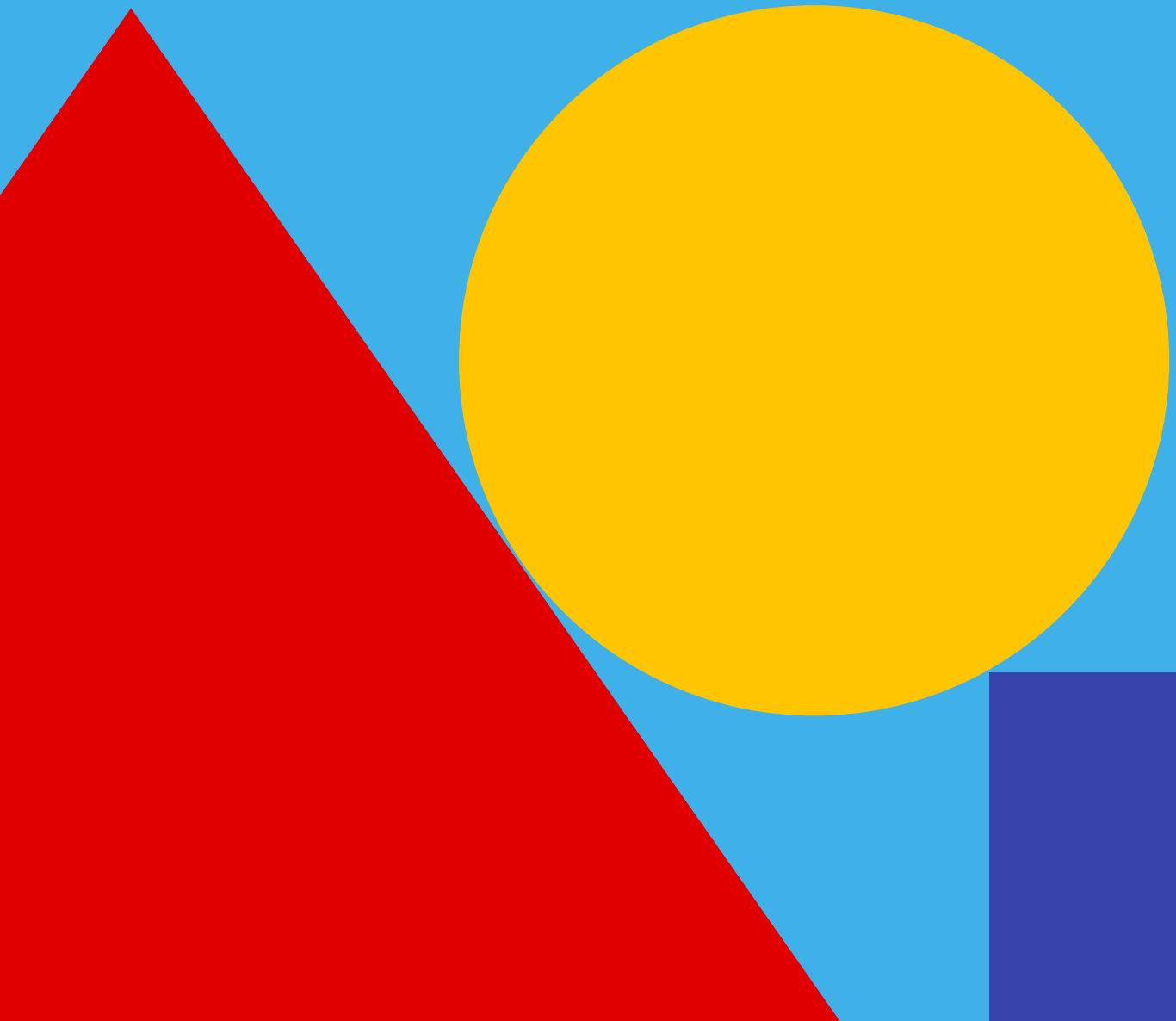
I·M3 Institute of Materials, Minerals & Mining

Materials-driven missions:

Delivering the *Plan for Change*



Summary Report

The 'Plan for Change: Milestones for a mission-led government' was launched in December 2024 and outlines Labour's ambitions for this parliament. It is divided into five missions - growing the economy, an NHS fit for the future, safer streets, opportunity for all, and making Britain a clean energy superpower.

All elements of the *Plan for Change* depend on the secure and sustainable management of material resources. Materials, minerals and mining industries input into virtually all products on our markets, enable the delivery of vital infrastructure and drive innovation and growth across sectors. These supply chains are particularly vital to mission 1, on kickstarting economic growth, mission 5, on making Britain a clean energy superpower, and the foundations of economic stability and national security. Based on the expertise of IOM3 members, this report outlines the role of materials industries in delivering these three broad policy objectives and unlocking synergies between them.

Strong Foundations:

The government has recognised that its missions for this parliament cannot succeed without strengthening economic stability and national security. This includes measures to promote macroeconomic stability, deter geopolitical threats and protect the UK from risks such as climate change, global economic downturns and supply chain disruptions. At the heart of these challenges is the question of economic sovereignty; the extent to which the UK can maintain reliable access to the resources and products we need in the face of an increasingly risky global landscape. Providing the building blocks of all essential commodities, the materials, minerals and mining industries are crucial in this regard.

Composites underpin a wide range of essential goods, including structural components for smart devices, lightweight bodywork for transport vehicles, military aerostructures, highspeed missiles and armour, and communication satellites. Despite this strategic value, the UK relies on imports for almost all high-performing composites and the concentration of supply in a small number of states creates major vulnerabilities.

Critical Raw Materials (CRMs) also referred to as critical minerals, are crucial to the stability and security of modern economies. Magnets, rechargeable batteries, electronics, hard metals, satellite solar cells, defence technologies and semiconductors all rely on CRM supply chains. Global markets for many of these materials are dominated by Chinese producers and the UK is heavily dependent on imports.

Polymers are deployed across vital sectors such as defence, healthcare, construction, clean energy and digital technology. Despite a strong base in polymer manufacturing, the UK has a plastics trade deficit of £4.6 billion[1] and plastic prices are highly vulnerable to shocks in global oil markets. As the international community moves to phase down virgin plastics use, building on the UK's existing strengths in sustainable plastics will be crucial to ensuring greater resilience in these essential supply chains.

These cases give just a sample of how stability and security are tied to material flows. Despite clear strengths and advantages, UK materials industries face pervasive challenges of import dependence, high energy costs, skills shortages and reliance on linear, primary supply chains. To build the *Plan for Change* on solid foundations, decisive government intervention is needed to boost domestic industrial capabilities and workforce capacity, increase circularity and build more diverse and transparent trade routes.

[1] https://www.bpf.co.uk/industry/Default.aspx#:~:text=In%202022%2C

[2] https://www.ceramics-uk.org/

[3] https://www.britglass.org.uk/our-work/trade-and-economy

[4] https://www.britglass.org.uk/our-work/people-skills/careers-glass-industry

Kickstarting Growth:

Plan for Change Milestone: raise living standards in every part of the United Kingdom

As well as feeding into essential products and services, materials, minerals and mining industries directly drive growth, employment and income levels across every region of the UK. Despite trends towards deindustrialisation, the UK maintains considerable strengths in these sectors that can be harnessed to boost growth.

Ceramics: The ceramics industry directly employs 17,500 people domestically, with thousands of more jobs supported in upstream and downstream supply chains. Almost every region holds one or more of the UK's 150+ ceramics sites[2], with the majority of manufacturers and end-users based in the Midlands.

Glass: The glass sector contributes approximately £1.3 billion to the UK economy each year[3], with 6,000 workers directly employed in the sector across Yorkshire, the Northwest, Essex, Scotland and Northern Ireland[4].

Metals: Metals manufacturing and processing is of huge economic and strategic value to the UK economy. In 2024, the steel sector alone contributed £1.7 billion in GVA to the UK economy, in addition to directly supporting 37,000 jobs[5]. The focus on quality assurance and high performance gives the indigenous metals sector a competitive advantage on the global market.

Polymers: Plastics manufacturing presents a significant growth opportunity. The sector has an annual sales turnover of £28.7 billion, with 5,700 companies employing approximately 150,000 people. Moreover, it is estimated that the industry indirectly supports an additional 400,000 jobs[6].

Extractive industries: Extraction remains a crucial economic activity in the UK, with over 185 million tonnes of minerals extracted from the earth for sale in 2022 alone[7]. In 2024, the mining and quarrying industries, including oil and gas, contributed £28 billion in gross value added to the UK[8] and directly employed 48,000 people[9].

Composites: Composites engineering is also a major growth-driving sector. Valued at £483 million in 2023[10], the industry directly employs up to 50,000 people in the UK[11]. It is a high value-added sector; wages are above the UK average and revenue per employee is over £268k[12], significantly higher than manufacturing sector norms.

Materials characterisation: Encompassing the systemic measurement of material properties and chemical makeup, materials characterisation underpins innovation, quality assurance and the development of advanced materials across a range of sectors. This activity contributes to the UK's competitive edge in global markets and delivers solutions in sustainability, energy efficiency and technological advancement.

Packaging: The packaging industry generates over £11 billion in revenue every year and directly employs 85,000 people in the UK[13]. Most of the skilled manufacturing jobs provided by the packaging sector are located outside of London and the Southeast, with major hubs in Yorkshire, the Northwest and the Midlands.

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[5] https://commonslibrary.parliament.uk/research-briefings/cbp-7317/

[6] https://www.bpf.co.uk/industry/Default.aspx

[7] https://www.bgs.ac.uk/news/uk-minerals-yearbook-2023-now-available-to-download/

[8] https://www.ons.gov.uk/economy/grossdomesticproductgdp/datasets/ukgdpolowlevelaggregates

[9] https://www.ons.gov.uk/employmentandlabourmarket/peopleinwork/employmentandemployeetypes/timeseries/jwr6/lms

[10] https://www.lucintel.com/uk-composites-market.aspx

[11] The UK's Composites Sector in numbers 2024", David Bailey, CEO, Composites UK https://compositesuk.co.uk/member-resources/association-information/agm-minutes-and-annual-reports/

[12] https://www.linkedin.com/posts/composites-uk_at-the-second-day-if-the-international-composites-activity-7237430520475758592-M25H/

[13] https://consult.defra.gov.uk/environmental-quality/plastic-packaging-tax/

Invest 2035: the 10 year-plan to deliver the certainty and stability businesses need to invest in the high growth sectors that will drive our growth mission.

Plan for Change Milestone: building 1.5 million homes in England and fast-tracking planning decisions on at least 150 major economic infrastructure projects.

The modern Industrial Strategy has the potential to offer an important roadmap for economic growth. It will focus on the eight priority sectors of advanced manufacturing; clean energy industries; creative industries; defence; digital and technologies; financial services; life sciences; and professional and business services. While this sector-specific focus offers a useful framework for targeted government intervention, a greater emphasis is needed on the role of materials, minerals and mining in upholding these industries.

Advanced Manufacturing: All advanced manufacturing relies on materials feedstocks, from the use of platinum in catalytic conversion processes, copper in electrical cables and construction materials in 3D printing to advanced functional films for structural glass and high-performance polymer materials for complex machinery components.

Digital and Technology: Similarly, the digital and technology sector is dependent on inputs of critical raw materials for the manufacturing of computers, servers, cables, and robotics. In addition, processed materials such as composites are vital to the integration of sensors and control systems, while polymers are deployed in the development of electronics casings, fibre optics and 3D printing filaments.

Life Sciences: Materials, minerals and mining are crucial across the life sciences, particularly in the development of biomaterials that can replace part of a living system or function in intimate contact with living tissue. These innovations are essential to the delivery of medical devices such as intravascular stents, heart valves, cardiac simulators, implants and prosthetics.

Defence: Finally, material flows are vital to the defence sector. Composites underpin the manufacturing of military aerostructures such as fighter jets and drones, ceramics are used in military products from body armour to hypersonic and missile systems, and critical raw materials are found in military systems such as firearms, jets, nuclear submarines and stealth technology.

The government has recognised that boosting growth will not be possible without delivering the infrastructure necessary to support businesses and workforces. The built environment is underpinned by materials at every level, from concrete, bricks, timber, steel and glass, to gypsum, chemical coatings and copper wiring.

Material flows are not only vital to building homes, but also to the construction and operation of strategic infrastructure such as transportation networks, gigafactories and data centres. Mineral products such as cement, concrete and asphalt are produced in the UK and are vital inputs in road and highway projects. Similarly, rail infrastructure relies on steel for tracks, metal alloys, composites and plastics for train construction and copper and aluminium for signalling systems. In the construction of data centres, polymers are essential for cable insulation, server components and cooling systems.

Achieving housing and infrastructure milestones will thus depend on the coordinated management and expansion of construction materials supply chains. Workforce capacity should be a key area of focus in this regard. The Construction Skills Network estimates that an additional 250,000 workers will be needed in the industry between 2024 and 2028, including stonemasons, glass and ceramics makers, metal plate workers, smiths, moulders and woodworkers[14].

Finally, the government must consider the relationship between construction ambitions and net zero targets. Construction materials tend to be energy and resource intensive and supporting decarbonisation and circularity in this sector will be vital to minimising environmental compromises in the delivery of the growth mission. Important measures include strategic planning for domestic reserves of construction minerals to ensure replenishment, investment in green innovations such as low carbon concrete admixtures and energy efficient architectural glass, and the full implementation of the carbon border adjustment mechanism (CBAM) to ensure decarbonised UK construction products can compete against imports.

Making Britain a Clean Energy Superpower:

Plan for Change Milestone: to secure our energy supply with home-grown, clean power.

All energy infrastructure and green technologies rely on the sourcing, processing and engineering of materials. As such, achieving 95% low carbon electricity generation by 2030 will require the coordinated scaling up of industrial activity across materials, minerals and mining supply chains.

Wind: Most of a wind turbine's mass is made up of steel, cast iron, composites, copper and aluminium[15]. There are an estimated 120 tonnes of steel needed per megawatt of wind capacity[16] and offshore farms require hundreds of kilometres of copper cables. Critical materials, including rare earth elements, are deployed in permanent magnets and wind turbine blades are manufactured with composites.

Solar: Important feedstocks for Photovoltaic (PV) solar energy include high grade glass, plastic encapsulants and back sheet layers to improve longevity, and silicon for the manufacturing of solar cells.

Carbon Capture, Utilisation and Storage (CCUS) and Hydrogen: The safe storage of gaseous hydrogen will require carbon fibre-based storage and the engineering of appropriate rubber materials for sealing systems. Similarly, CCUS will not be possible without the development of advanced material coatings that can withstand corrosion. In both technologies, polymers will be essential for piping and membrane systems.

The Grid: The delivery of the onshore electricity network required to achieve clean power by 2030 will be a materially intensive process. Significant volumes of steel will be needed to construct pylons, composites and ceramics will be essential as insulators for power lines, aluminium and copper will be needed for wiring and cables and concrete will be required for foundations.

Given the scale of the resources involved, fostering circular supply chains will be crucial to the UK's energy transition. Many of the materials and minerals needed to deliver clean energy are already embodied in end-of-life assets in the UK, including critical raw materials in electric vehicle batteries, large volumes of steel in oil and gas rigs nearing decommissioning and high-quality copper in end-of-life subsea cables. With targeted policy planning and investment, there is the potential to repurpose these resources to deliver the clean energy infrastructure of the future.

Another key area of focus for the transition to clean energy is import dependence and the security of material supply chains. Under the status quo, the majority of materials used in the clean energy sector are imported as intermediary products. This includes composite materials used in the roll-out of wind energy, batteries essential for the incorporation of renewables into the grid and PV solar panels. Many clean energy supply chains are dominated by Chinese producers, with this concentration of supply creating significant vulnerabilities for the UK. Fostering transparent and diverse materials trade routes and strengthening domestic production where possible will be essential to insulating the clean energy sector from global shocks.

Finally, to achieve clean power by 2030, a greater focus on workforce capacity in materials, minerals and mining sectors is needed. The employment opportunities associated with the transition span across the full supply chain, encompassing manufacturing jobs in plastic components for wind turbines, solar panels and battery storage systems; high quality research and engineering jobs in materials characterisation for clean energy solutions; and composites roles in wind turbine blade production and lightweighting technology.

The economic and environmental benefits of these opportunities cannot be harnessed without addressing severe skills shortages across the materials cycle. An inadequate pipeline of skilled workers is already causing challenges in critical sectors such as composites, coatings and surface technology, elastomers, mining and decommissioning. Strategic government intervention is needed to raise the profile of materials sectors and ensure the sufficient rollout of education and training programmes to meet future demand.

[14] https://www.citb.co.uk/media/3j4jj3lo/ctb1003_csn_technical-doc_aw2.pdf

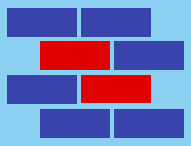
[15] https://www.nrel.gov/docs/fy17osti/66861.pdf

[16] https://windeurope.org/newsroom/press-releases/ensuring-access-to-critical-materials-for-steel-and-wind-sectors-essential-for-eu-clean-tech-economy/

Next Steps

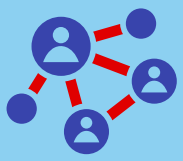
From its foundations to its milestones, the success of the government's *Plan for Change* is dependent on a resilient and thriving materials sector. The focus on downstream supply outputs, and the assumption that material challenges will be addressed by end-use sectors, are outdated in the current global landscape. Proactive action is needed to capture the growth potential of material sectors and responsibly manage the physical resources on which our economy depends. In this vein, the government should:

Data gathering: Conduct comprehensive, cross-economy data collection on the material flows and skills needed to deliver the *Plan for Change*.



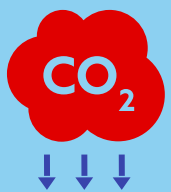
Building domestic capability: Undertake targeted intervention to build domestic supply chain capacity in areas where gaps are identified, including through investment in infrastructure, support for R&D, strategic industrial planning, energy subsidies and increased regulatory clarity.

Overcoming skills gaps: Tackle skills shortages in materials sectors, including through awareness raising at all educational levels and funding for relevant degrees, apprenticeships and training programmes.



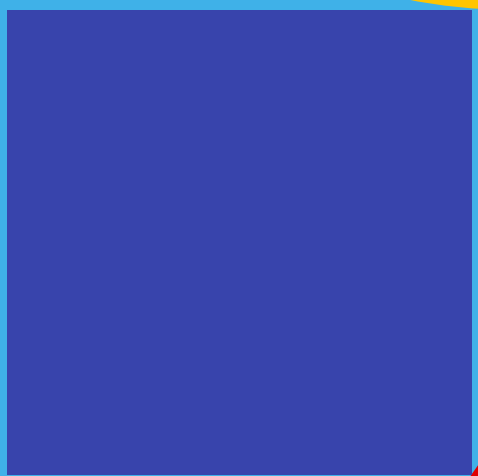
Cross-sector coordination: Develop and implement a cross-industry, cross-departmental National Materials Strategy to ensure the coordinated, efficient and responsible management of material flows needed to deliver the *Plan for Change*.

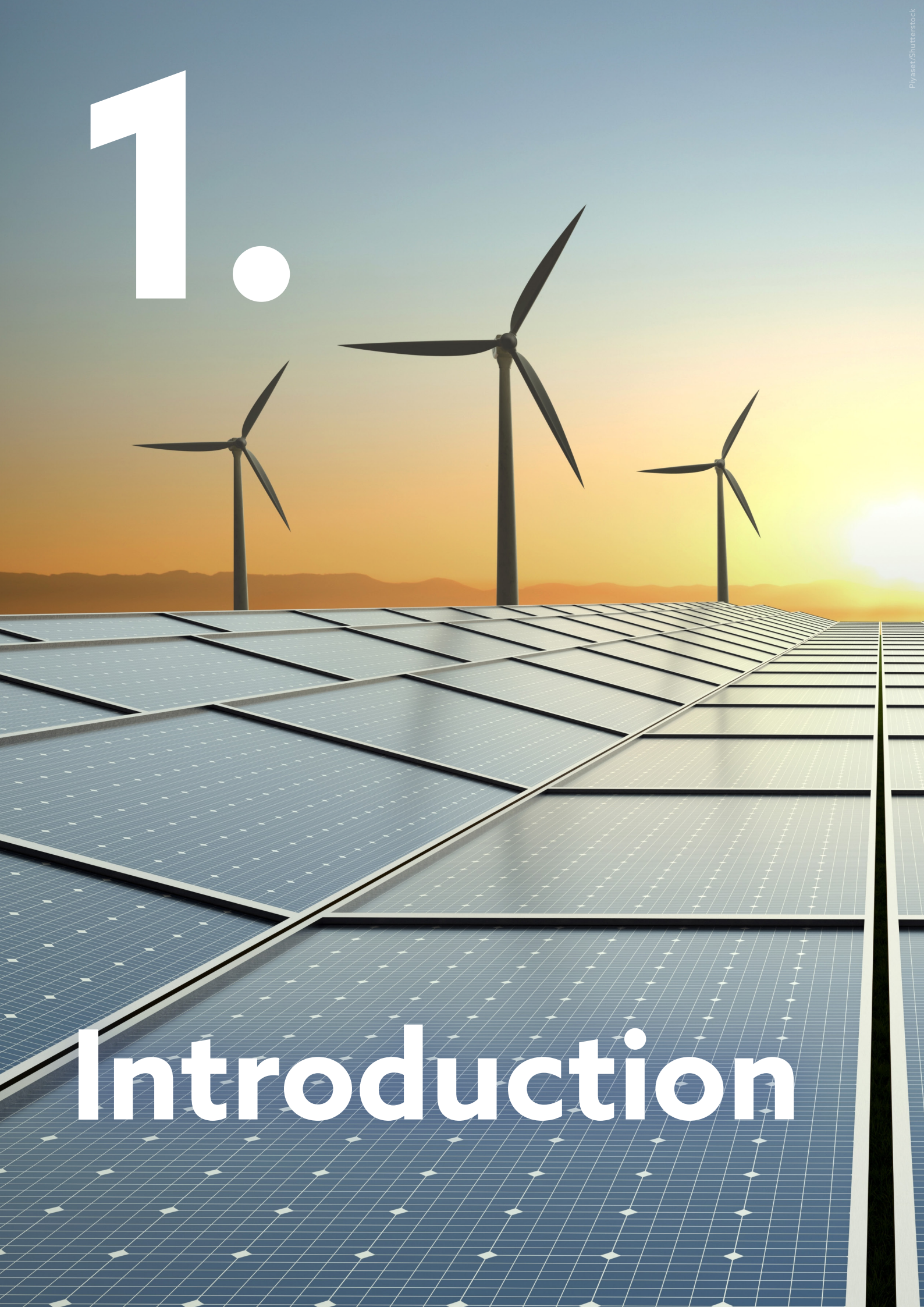
Strengthening circularity: Prioritise the shift towards a resource-efficient and circular economic model and ensure that the implementation of the *Plan for Change* aligns with and reinforces the Circular Economy Strategy.



Decarbonisation: Ensure energy intensive materials industries in the UK remain competitive in the transition to net zero, including through the support for decarbonisation and measures to reduce energy costs.

A full-supply chain approach: Adopt a full-supply chain approach in the implementation of the *Plan for Change,* including by systemically incorporating questions of materials management and sustainability into government strategies on security, growth and energy.



1. Introduction

The *'Plan for Change: Milestones for a mission-led government'* was launched in December 2024 and outlines the Labour government's ambitions for this parliament. It is divided into five missions - growing the economy, an NHS fit for the future, safer streets, opportunity for all, and making Britain a clean energy superpower. The plan also outlines six milestones against which progress can be tracked and assessed. These include building 1.5 million homes, delivering the highest sustained economic growth in the G7 and achieving at least 95% clean power by 2030. Finally, all missions and milestones are underpinned by three foundations which the government has identified as essential to delivering change in an increasingly volatile global landscape. These are economic stability, secure borders and national security.

All elements of the *Plan for Change,* its foundations, missions and milestones, depend on the secure and sustainable management of material resources. Materials, minerals and mining industries input into virtually all products on our markets, enable the delivery of vital infrastructure and drive innovation and growth across sectors. These supply chains are particularly vital to mission 1, on kickstarting economic growth, mission 5, on making Britain a clean energy superpower, and the foundations of economic stability and national security.

Based on the expertise of IOM3 members across sectors, this report outlines the role of materials industries in delivering these three broad policy objectives. It maps the strengths and opportunities that can be harnessed to achieve progress, as well as the barriers that must be overcome to maintain necessary material flows. The findings illustrate an urgent need to bolster domestic capacity in the materials, minerals and mining industries and support the transition to a low-carbon, circular and resource-efficient economy. A consistent policy framework to incentivise decarbonisation and circularity, alongside investment in skills and infrastructure, will be essential in this regard. More fundamentally, the materials cycle must be recognised and understood by government as vital to the delivery of the *Plan for Change* and systematically addressed in the implementation of missions and milestones.

While the structure of this report approaches the foundations, the growth mission and the energy mission as three discreet topics, the relationship between these in practice is also a vital consideration. While trade-offs between sustainability, security and growth are by no means inevitable, a carefully coordinated approach is needed to ensure that the government's strategies in these areas are mutually reinforcing. Providing the common building blocks of green technologies and growth-driving industries, the materials cycle holds the key to unlocking synergies between the government's missions and fostering an economic landscape capable of supporting an energy transition, enhanced security and rapid growth simultaneously. The strategic scale-up of material capabilities and innovation required to meet this challenge will demand a proactive and joined-up approach from government.

As such, this report recommends the development and implementation of a cross-department, cross-industry National Materials Strategy aimed at meeting future demand across materials supply chains in a responsible, resilient and secure manner. The National Materials Innovation Strategy launched by the Henry Royce Institute represents an important first step towards a more coordinated approach to the materials cycle. The strategy should be implemented at pace, fed into government policy and built on to deliver a National Materials Strategy encompassing not only innovation, but also the sustainable and forward-looking management of the full materials lifecycle, from exploration to after end-of-life.

2.

Strong foundations

2.1 Materials for national security and economic stability

The *Plan for Change* has been launched in a time of significant global uncertainty owing to factors such as rising protectionism, ongoing overseas conflicts and the threat of climate change. The government has recognised that its objectives for this parliament cannot be achieved without strengthening economic stability and national security. According to the *Plan for Change,* this includes boosting the UK's resilience to shocks, delivering long term policy certainty, promoting macroeconomic stability, deterring geopolitical threats and protecting the UK from risks such as climate change and supply chain disruptions. These foundations determine the UK's capacity to adapt and recover from adverse events, ranging from overseas conflicts and unpredictable trade regimes to global recessions and environmental crises.

At the heart of these challenges is the question of economic sovereignty; the extent to which the UK can maintain reliable access to the resources and products we need in the face of an increasingly risky global landscape. Materials form the building blocks of virtually all essential commodities on our markets, from pharmaceuticals, digital technologies, automotives and energy infrastructure, to household items like food packaging, home appliances and clothes. The efficient, sustainable and responsible management of the materials cycle is therefore crucial to bolstering the UK's economic independence and creating the conditions for increased stability and security.

Across the materials, minerals and mining sectors intervention is required to strengthen domestic capability, increase circularity and build more diverse trade routes. The UK has a major dependence on linear global supply chains for the raw and processed materials needed to meet the demands of modern society. Moreover, acute and ongoing skills shortages in domestic materials sectors, including composites, coatings and surface technologies, elastomers, metallurgy, mining, packaging and recycling, limit the UK's potential to increase sovereign industrial capacity.

While it is neither feasible nor desirable to onshore the entire materials supply chain domestically, there are serious challenges associated with the status quo. Reliance on increasingly fickle and opaque global supply chains leaves the UK vulnerable to shocks associated with geopolitical crises, environmental and social governance (ESG), resource depletion and global economic downturn. Perhaps the most striking recent example of this was seen in 2022 during the outbreak of war in Ukraine, when disruptions to gas supplies triggered a surge in inflation, with major ramifications for business costs and living standards alike.

These macroeconomic and security risks are not limited to energy. Wherever materials are essential to daily life, supply chain vulnerabilities and poor resource management undermine the UK's resilience. The following examples indicate the significance of these challenges and the necessity of strengthening domestic capacity:

Composites

Composites underpin the delivery of essential goods, services and infrastructure across a wide array of industries. The sector encompasses a significant breadth of materials, including metal-, ceramic- and polymer-matrix composites. These materials are uniquely suitable as structural materials for smart devices, including laptops and smart phones. They are also vital in the aviation industry where they are used in the production of complete aerostructures and in the small marine industry for the production of hulls and fittings. Land transportation industries also rely heavily on composites, including for car, bus, truck and train bodywork, as well as for electric vehicle battery packs. Moreover, they are of huge importance to defence, security and resilience. Composites are the default materials for military aerostructures such as fighter jets and drones and are utilised in communications satellites, military vehicles, high-speed missiles, anti-tank weapons, armour and radar transmission structures in naval assets.

Despite their strategic importance, the UK relies on imports for almost all high-performing composites. There is little to no domestic production and the supply of these materials is often heavily concentrated in a single trading partner. For example, high-performance ceramic matrix composites, with important applications in defence and manufacturing, are entirely dependent on the US for the supply of oxide fibres and on Japan as the primary source for silicon carbide

fibres. Due to this concentration of supply, imports of these materials are extremely vulnerable to changes in overseas trade policies. Similar levels of import dependence can be seen across other composite materials, including aramids and ultra-high-molecular-weight-polyethylene. In addition, there is an overreliance on imports for manufacturing tooling and equipment for composites, such as automated fibre placement, large presses and so on.

Investment in composites production is urgently needed to ensure the resilience of critical supply chains. Growing the UK's domestic capacity in this field will require targeted intervention, including to overcome pervasive skills shortages at all levels of composites engineering. In addition, measures to improve circularity in the composites sector, including investment in the recycling and reuse of composites after end-of-life, are vital to boosting supply security. Progress in this area is especially critical given the increasing volume of secondary composites material in retired wind turbines and small boats that can be repurposed to meet future supply.

Critical Raw Materials (CRMs)

Critical raw materials, also known as critical minerals, are vital to the stability and security of modern economies. The UK has identified 34 CRMs including cobalt, used in magnets, hard metals and rechargeable batteries; niobium, applied in high-strength, low-alloy steel used to manufacture vehicle bodies; magnesium, used in transportation, packaging and construction; and ruthenium, used in electronics, chemicals and electrochemicals[1]. As this sample indicates, CRMs are important to a wide array of industries, including energy technologies, digitisation, electric vehicles, advanced manufacturing and construction[2].

Particularly as the UK and others move towards net zero, the demand for CRMs is expected to rise dramatically in the coming years.

A major economic and security risk associated with CRMs is the concentration of supply in the hands of a small number of states. China is one of the largest producers of critical minerals at the point of extraction and its dominance at the processing, production and export stages is a growing concern. For example, despite possessing just 8% of global lithium reserves, China hosts 44% of intermediate lithium carbonate and hydroxide production and 70% of the world's lithium-ion battery-cell production[3]. In addition, China accounts for over 75% of natural graphite production, 95% of synthetic graphite production and dominates global graphite refining[4].

Ensuring a strong foundation of economic security and national stability in the UK requires a comprehensive and proactive approach to CRM supply chains. A key priority in this regard is working with like-minded international partners to achieve more resilient, transparent and diversified global trade routes. In addition, the government can support the sustainable and responsible sourcing of domestic mineral reserves. The Critical Mineral Intelligence Centre has highlighted that there are known deposits of lithium, tin, tungsten, strontium, nickel and cobalt in the UK, as well as significant potential for the discovery of copper, lead, zinc and more. While further data is needed to support mineral exploration and mine development, such projects have the potential to contribute to the UK's security of supply if proven to be economic[5].

Nevertheless, it will not be feasible for the UK to meet its demand for CRMs through domestic extraction alone. As such, the reuse of CRMs already in circulation, sometimes called 'urban mining', will be vital to minimise reliance on primary supply, bolster economic sovereignty and reduce the environmental intensity of growth. The transition towards a circular model will require a coordinated, full supply chain approach, with a huge increase in design for recycling, reuse and repair, as well as recycling infrastructure, to enable the recovery of materials after end-of-first-life. Moreover, a broader shift in industrial norms and practices is needed to move away from linear supply chains and prioritise the retention of value

[1] https://www.bgs.ac.uk/news/uk-2024-criticality-assessment/

[2] https://www.iisd.org/system/files/2023-09/critical-minerals-primer-en.pdf

[3] Mining Journal 2022, Lithium Outlook – can EV battery metal continue its incredible bull run? 2 December 2022, page 13, https://documents.chitra.live/api/v1/documents/f1766fcc-eff3-4dae-a5d5-abf5b406035c/download

[4] https://www.csis.org/analysis/china-imposes-its-most-stringent-critical-minerals-export-restrictions-yet-amidst#:~:text=China%20accounts%20for%2077%20percent%20

[5] https://www.ukcmic.org/downloads/reports/ukcmic-2024-criticality-assessment.pdf

in secondary materials. The recycling of platinum group metals by Johnson Matthey is a concrete example of how this can work in practice and deliver significant benefits in the UK.

With regards to both primary extraction and recovering secondary materials, a sufficient pipeline of adequately skilled workers is essential. As is highlighted in the IOM3 report, *'The talent gap: critical skills for critical minerals'*, the UK is facing severe and worsening skills shortages in CRM supply chains from extraction to end-of-life management. If the UK is to achieve reliable and sustainable access to CRMs, targeted government intervention is needed to overcome these challenges.

Polymers

Plastics continue to play an important social and economic function, underpinning the delivery of vital products and services. Plastics are used in healthcare for medical devices, PPE and drug delivery systems; in construction for insulation and pipes; in packaging for food safety and extended shelf life; and in digital technology for electronics casings, fibre optics and 3D printing filaments/ Plastics are also essential to the national security sector as they are used in manufacturing lightweight and durable equipment for defence applications to improve mobility and protection.

Despite having a strong base in polymer manufacturing, the UK has a plastics trade deficit of £4.6 billion, indicating that we rely on the import of huge volumes of plastics to meet domestic need[6]. This is a concern for several reasons. As polymers are a petrochemical derivative, their cost is heavily influenced by fluctuations in oil prices associated with geopolitical shifts, extraction costs, reserve depletion, legal developments and transportation expenses[7]. Plastic price volatility can have knock-on impacts on the stability of business and consumer costs.

These supply chain risks should be understood in light of ongoing negotiations on a Global Plastics Treaty and the stated intention of the UK and many of our international partners to reduce virgin plastics throughput. Such ambitions represent a huge shift from current industrial norms and will require significant international coordination, which has proven challenging[8]. Ensuring the efficient and responsible management of polymer supplies domestically will be vital for the UK to rise to the challenge of forthcoming reforms, while still meeting domestic need. Building on the UK's existing strengths in sustainable plastics will be crucial. These include strong research institutions, pioneering efforts in recycling, bioplastics, and sustainable materials, leadership in international standard setting and early adoption of policies pushing towards more sustainable plastic use and production.

The importance of circularity in ensuring the resilience of polymer supply chains cannot be overstated. Building on the UK's existing strengths in innovative recycling processes, the government should strive to deliver the policy environment and infrastructure required to keep plastics in circulation at their highest value for as long as possible. In doing so, it is possible to markedly reduce the demand for virgin plastics across the UK economy. This can in turn minimise import dependence, insulating businesses and consumers from the worst impacts of supply chain instability, while also offering an economically viable means to lead on global plastics reforms.

2.2 A strategic approach to materials

The industries explored above give just a sample of how stability and security are tied to the responsible management of the materials cycle. In each, the UK has clear strengths and advantages, however these must be strategically harnessed to ensure sustainable and reliable access to the resources our society needs. Key areas for government intervention in this regard include boosting domestic industrial capabilities and workforce capacity; fostering diverse, secure and transparent trade routes; and accelerating the shift towards a circular economy. Across sectors, circularity in particular will be key to reducing the material intensity of economic activity and insulating growth from the environmental, social and geopolitical risks associated with primary supply chains. Ensuring that a skilled labour pool is available to develop domestic materials, minerals and mining capability and responsibly manage these sectors from extraction to after end-of-first life will also be vital.

[6] https://www.bpf.co.uk/industry/Default.aspx#:~:text=In%202022%2C%20the%20UK%20exported,plastic%20and%20plastic%20products...&text=It

[7] https://www.defthedge.com/en/raw-materials-management/plastic-price/

[8] https://www.iom3.org/resource/no-agreement-reached-on-global-plastics-treaty-at-inc-5.html

The government's *Plan for Change* is well positioned to deliver on these necessary reforms, having recognised from the outset that ambitious policy aims can only be delivered on a foundation of economic stability and national security. That said, a greater emphasis on the role of materials, minerals and mining is required.

Time and again it has been shown that when the raw and processed materials needed to sustain economic activity are made precarious, economic upheaval closely follows. Indeed, perhaps the greatest threat to stability in recent years has been global cost-push inflation, driven by the increased production costs associated with rising energy materials prices. As such, while the government's intentions to oversee responsible public finances are crucial, this can only support long term economic stability insofar as it is paired with the strategic and responsible management of material flows.

Similarly, the goal of enhanced national security requires a holistic approach. As is highlighted above, all defence applications are underpinned by materials, minerals and mining products and the skilled workforces that deliver them. However, in an increasingly interdependent global environment, the meaning of national security extends far beyond the realm of military capacity. Dependence on opaque and volatile supply chains, the linear depletion of vital material resources, and worsening skills gap in the materials, minerals and mining sectors all undermine the UK's sovereign capability to meet domestic need. This exacerbates vulnerability to external shocks and represents a major security risk.

To build the *Plan for Change* on solid foundations, the government must prioritise the transition to a resilient and resource-efficient materials supply chain. The current approach, which assumes material challenges will be overcome by end-use sectors, is insufficient in an increasingly volatile global market. A cross-government, cross-economy National Materials Strategy is needed to deliver the responsible and effective management of materials across their full lifecycle. This should include measures to protect supply chains, capabilities and technologies of strategic importance, invest in the UK's materials processing industry, tackle skills shortages in key industries and develop a clear regulatory landscape for the safe and sustainable use of new materials.

3.

Kickstarting economic growth

3.1 Materials as a catalyst for growth

Plan for Change Milestone: raise living standards in every part of the United Kingdom.

The government's ambition to deliver the highest sustained growth in the G7 cannot be achieved without a strategic approach to the materials cycle. Materials, minerals and mining sectors not only feed into vital industries for our economy, as described above, but also directly drive growth, employment and income levels across every region. Despite trends towards deindustrialisation, the UK maintains considerable strengths in these sectors that can be harnessed to boost growth. The materials innovation sector is worth £45 billion annually to the UK economy, directly employing 52,000 people and indirectly supporting an estimated 635,000 jobs. Materials are also the bedrock of the UK's manufacturing industry, which contributes £220 billion in GVA every year and supports 2.6 million jobs. 85% of manufacturing activity takes place outside of London and the Southeast[9]. The high potential for materials to drive economic growth and living standards is seen across a number of sectors.

Ceramics

Ceramics is both a foundation and an advanced industry, with applications ranging from tableware and tiling to construction, refractories, electronics, aerospace, defence and green technologies. The sector has an annual revenue of £1.6 billion across the supply chain, with £600 million in exports. 17,500 people are employed in ceramics, with thousands of more jobs supported in upstream and downstream supply chains. The benefits of this economic activity are felt across the nation, as almost every region holds one or more of the UK's 150+ ceramics sites[10], with the majority of manufacturers and end-users based in the Midlands. However, ceramics also face a high risk of carbon leakage in the transition to net zero and investment in decarbonisation is needed to harness the sector's full potential.

Glass

The glass industry contributes approximately £1.3 billion to the UK economy each year[11], with 6,000 workers directly employed in the sector across Yorkshire, the Northwest, Essex, Scotland and Northern Ireland[12]. Moreover, glass supply chains support productivity and employment across a range of other sectors, including through the use of architectural glass in construction, glass containers in sustainable packaging and various applications in digital technology, defence and advanced manufacturing.

Metals

The metals industry is also of huge economic and strategic value to the UK, feeding into industries from construction, defence and transportation to machinery and healthcare equipment. In 2024 the steel sector alone contributed £1.7 billion in GVA to the UK economy, in addition to directly supporting 37,000 jobs[13]. The focus on quality assurance and high performance gives the indigenous metals sector a competitive advantage on the global market, as seen in the fact that UK contractors are among the very few firms outside of America authorised to supply components to the United States Navy. As in other materials sectors, support for the decarbonisation of metals production will be a prerequisite for capturing future growth opportunities.

Polymers

In addition to underpinning a wide array of products and infrastructure, the polymer sector presents a significant growth opportunity for the UK. Plastics currently have an annual sales turnover of £28.7 billion in the UK, with 5,700 companies employing approximately 150,000 people. Moreover, it is estimated that the industry indirectly supports an additional 400,000 jobs[14]. The vast majority of this activity takes place outside of London and the Southeast, with the highest concentration of plastics firms located in the Midlands and Northwest[15]. The UK's existing

[9] https://www.royce.ac.uk/content/uploads/2025/01/Royce_NMIS_booklet-digital_FINAL-SINGLE.pdf

[10] https://www.ceramics-uk.org/

[11] https://www.britglass.org.uk/our-work/trade-and-economy

[12] https://www.britglass.org.uk/our-work/people-skills/careers-glass-industry

[13] https://commonslibrary.parliament.uk/research-briefings/cbp-7317/

[14] https://www.bpf.co.uk/industry/Default.aspx

[15] https://www.bpf.co.uk/industry/Default.aspx

strengths in sustainable polymers and plastics recycling create the potential for further growth in light of national and global ambitions to reduce virgin plastic throughput.

Extractive industries

Extraction remains a crucial economic activity in the UK, with over 185 million tonnes of minerals extracted from the earth for sale in 2022 alone[16]. In 2024, the mining and quarrying industries, including oil and gas, contributed £28 billion in gross value added to the UK[17] and directly employed 48,000 people[18]. Extractive jobs are regionally diverse and have long been a source of good quality employment and growth in areas with limited economic opportunity. Extractive projects can have major knock-on benefits for the local economies, as they will often require the development of additional infrastructure and services. Everything from upgrading roads to additional catering services for workers can bring jobs and additional income to local communities. Indeed, research has suggested that for every 100 jobs created in a mine, an additional 100 are created in supporting sectors[19].

Composites

In addition to delivering a wide range of strategically important products, the UK composites sector is a major growth driver, valued at £483 million in 2023[20]. Market research from Lucintel suggests that there are 400 companies working on composites in the UK, with a total employment of about 30,000 people[21]. However, these figures have been regarded by some as understated and the trade association Composites UK estimates the domestic composites supply chain encompasses up to 1,000 firms and 50,000 workers[22]. Composites is a high value-added sector; wages are above the UK average and revenue per employee is over £268,000[23], significantly higher than manufacturing sector norms. The return on investment within the composites industry is also very high, with reports suggesting that for every £1 of raw materials consumed by the sector, products are produced with a value of £7[24].

Materials characterisation

Materials characterisation, encompassing the systemic measurement of material properties and chemical makeup, is also a major driver of growth in the UK. The discipline underpins innovation, quality assurance and the development of advanced materials across a range of sectors. This activity contributes to the UK's competitive edge in global markets and delivers solutions in sustainability, energy efficiency and technological advancement. For example, Northumbria University is a leader in research on ocean tribology, the study of friction, wear and lubrication in marine environments, and is contributing to technological innovation for offshore renewables.

The UK has major strengths in materials characterisation stemming from its world-class research institutions, strong industrial base and leadership in advanced materials. Research hubs across the UK, including the Advanced Manufacturing Research Centre in Sheffield and the Materials Innovation Factory in Liverpool, leverage regional strengths and collaborate with local stakeholders to drive growth. The regional employment provided by materials characterisation industries is highly skilled and productive.

Packaging

From food and healthcare to manufacturing and retail, packaging materials are crucial to maintaining the supply of essential products. The packaging industry generates over £11 billion in revenue every year and directly employs 85,000 people in the UK[25].

[16] https://www.bgs.ac.uk/news/uk-minerals-yearbook-2023-now-available-to-download/#:~:text=The%

[17] https://www.ons.gov.uk/economy/grossdomesticproductgdp/datasets/ukgdpolowlevelaggregates

[18] https://www.ons.gov.uk/employmentandlabourmarket/peopleinwork/employmentandemployeetypes/timeseries/jwr6/lms

[19] https://link.springer.com/article/10.1007/s13563-017-0103-1

[20] https://www.lucintel.com/uk-composites-market.aspx

[21] https://iuk-business-connect.org.uk/wp-content/uploads/2021/07/Opportunities-in-the-UK-Composites-Industry-Lucintel-Public-Version.pdf

[22] "The UK's Composites Sector in numbers 2024", David Bailey, CEO, Composites UK https://compositesuk.co.uk/member-resources/association-information/agm-minutes-and-annual-reports/

[23] https://www.linkedin.com/posts/composites-uk_at-the-second-day-if-the-international-composites-activity-7237430520475758592-M25H/

[24] Lucintel report "UK Composites Industry Competitiveness and Opportunities", presented to Innovate UK and HVM-C, Dec 3rd 2020

[25] https://consult.defra.gov.uk/environmental-quality/plastic-packaging-tax/

Most of the skilled manufacturing jobs provided by the packaging sector are located outside of London and the Southeast, with major hubs in Yorkshire, the Northwest and the Midlands. Key strengths of the UK packaging sector include leading research institutions working on biodegradable materials and circularity, a high concentration of packaging engineering talent, advanced manufacturing capabilities for complex packaging solutions and a strong regulatory framework that ensures high-quality outputs. However, the industry also faces the challenges of rising raw material costs, heightened international competition and the need for ongoing investment in sustainable solutions.

Harnessing growth potential

As these examples and many others illustrate, materials industries are not only a feedstock for economic activity but are also a direct source of value creation. The growth of these industries across the UK often creates an economic multiplier effect, including through job creation in supporting industries such as transport and maintenance and investment in technical training and upskilling programmes. To fully harness the opportunities for growth in these sectors, policymakers must not only build on the distinct strengths of materials industries highlighted above, but also proactively address cross-sectoral challenges and broader trends towards deindustrialisation.

A key task for government in this regard will be combatting high energy prices. Materials, minerals and mining industries are often energy intensive and thus highly vulnerable to fluctuations in cost. There have, for instance, been cases of manufacturers of construction materials ceasing production during energy price spikes. Since 2022, UK energy prices have risen faster than the EU average and by the first half of 2024 the UK had higher industrial electricity costs than any EU member[26]. These trends undermine the competitiveness of UK industry in the European market and disincentivise the electrification of materials sectors crucial to net zero targets. Government intervention, including investment in clean energy infrastructure, rebalancing the prices of electricity and fossil fuels, and energy subsidies for strategic industries, is urgently needed to reduce costs and protect growth and employment across the full supply chain.

Another factor crucial to leveraging the growth potential of materials industries is skills. As noted above, acute and growing skills shortages are pervasive throughout these sectors. The delivery of the *Plan for Change* will depend in part on the strategic expansion of domestic industry, which cannot succeed without access to a sufficiently skilled workforce. The government can help tackle shortages through measures such as awareness raising on careers across the materials cycle, investment in degrees and training programs relevant to the demands of industry, coordination between industry and educational institutions to support upskilling and apprenticeships programmes and fiscal incentives for employers to train in new talent in key sectors.

3.2 Materials, Minerals and Mining for the Modern Industrial Strategy

Invest 2035: the 10 year-plan to deliver the certainty and stability businesses need to invest in the high growth sectors that will drive our growth mission.

The modern Industrial Strategy has the potential to offer an important roadmap for economic growth by establishing the clear and predictable policy landscape needed for investment, innovation and effective business planning. The Industrial Strategy will focus on eight priority sectors, identified by government as having a high growth potential. These sectors are advanced manufacturing; clean energy industries; creative industries; defence; digital and technologies; financial services; life sciences; and professional and business services. This sector-specific focus presents a useful framework for the government to take targeted and proactive intervention towards its goals. That said, if the strategy is to be successful, a greater and more explicit emphasis on the roles of materials, minerals and mining sectors will be required. Materials are the foundation of the real economy and, as such, industrial planning can only be as strong as the secure and responsible management of the materials cycle.

Materials, minerals and mining industries underpin all eight growth-driving sectors outlined in the Industrial Strategy Green Paper, playing a particularly vital role in advanced manufacturing, clean energy,

[26] https://assets.publishing.service.gov.uk/media/6762955acdb5e64b69e30703/quarterly-energy-prices-december-2024.pdf

defence, digital technologies and life sciences. Some crucial applications of materials and materials sciences in these growth-driving sectors include:

Advanced Manufacturing

All advanced manufacturing relies on materials, minerals and mining feedstocks. Important examples include the use of platinum in catalytic conversion processes, copper in electrical cables, construction materials in 3D printing, ceramics for cutting tools, advanced functional films for structural glass and high-performance polymer materials for complex machinery components. In addition to providing critical inputs into manufacturing processes, materials industries also drive innovation in the advanced manufacturing field. According to the Henry Royce Institute, manufacturing engineering firms account for one-third of companies active in materials innovation. Key areas of work include optimising and adapting material properties, expanding applications of existing materials and developing new materials[27]. Such advances can improve efficiency, reduce waste and enable the production of more complex components, thus driving productivity across advanced manufacturing industries.

Digital and Technology

Similarly, materials are a linchpin of the digital and technology sector. Most technological systems rely on either primary or secondary inputs of raw materials for the manufacturing of computers, servers, cables, and robotics. Critical raw materials such as cobalt, lithium and silicon are particularly important for the digital technologies that modern society depends on.

Processed materials, and the skilled workforces that produce them, are equally vital. For instance, composites are uniquely suitable as structural materials for the integration of sensors and control systems; polymers are deployed in the development of electronics casings, fibre optics and 3D printing filaments; advanced ceramics are used in the production of electronic components and sensors; and glass materials are vital in display systems and communications. Moreover, innovation in materials sciences enable the development of smaller, faster and more energy efficient components by optimising material properties at the nanoscale.

Life Sciences

Materials, minerals and mining are crucial across the life sciences, in particular biomedical and pharmaceutical industries. The development of biomaterials that can replace part of a living system or function in intimate contact with living tissue is essential to medical devices ranging from intravascular stents, heart valves and cardiac simulators, to implants and prosthetics[28]. Material sciences ensure the stability, bioavailability and performance of pharmaceutical products and improve the safety and efficacy of medical devices. In addition, materials are vital in the effective packaging of medical products, including in the design of sterile medical device packaging, tamper-evident pharmaceutical packaging and temperature sensitive vaccine distribution systems.

The UK has many strengths in the biomedical materials sector, particularly in orthopaedics, surgical instruments, wound dressings and diagnostic devices. These industries are especially strong in West and South Yorkshire, where they make a key contribution to regional economic development. For example, the surgical blade industry employs approximately 400 people in Sheffield, with a manufacturing capacity of over 1 million blades per day[29]. Building on existing advantages in the medical device, biopharmaceutical and biomedical materials industries, including through the expansion of NHS infrastructure, is a key growth opportunity.

Defence

Finally, materials, minerals and mining industries are essential to the UK's defence capabilities. Composites underpin the manufacturing of military aerostructures such as fighter jets and drones, ceramics are used in military products from body armour to hypersonic and missile systems, polymers are crucial to improving durability and mobility in defence applications and critical raw materials are found in military systems such as firearms, jets, nuclear submarines and stealth technology.

[27] http://royce.ac.uk/content/uploads/2024/04/Royce-National-Materials-Innovation-Strategy-April-2024.pdf

[28] https://www.sciencedirect.com/topics/materials-science/biomedical-materials#:~:text=A%20common%20definition%20of%20a,intimate%20contact%20with%20living%20tissue.

[29] https://www.swann-morton.com/faqs/company

Moreover, innovation in materials industries will drive the next generation of defence systems. To accelerate progress, greater government support is needed for research in areas such as lightweighting for increased fuel efficiency; high-strength materials; quantum and photonic materials to enable secure communications; and self-healing and adaptive materials to extend the lifespan of military assets.

3.3 Rebuilding Britian with Materials, Minerals and Mining

Plan for Change Milestone: building 1.5 million homes in England and fast-tracking planning decisions on at least 150 major economic infrastructure projects.

The government has recognised that boosting growth will not be possible without delivering the infrastructure necessary to support businesses and workforces. The built environment is underpinned by materials at every level, from concrete, bricks, tiles, timber, steel and glass, to gypsum, chemical coatings and copper wiring. While of vital importance to our economy and society, construction materials also tend to be energy and resource intensive. Indeed, approximately half of all raw materials extracted from the earth are used in construction[30]. The responsible and effective management of construction material supply chains is thus vital both for reaching the government's infrastructure milestones and for ensuring the compatibility of growth with environmental targets.

The UK has substantial strengths to develop on in construction materials. Large product manufacturers, located primarily outside of London and the Southeast, contribute substantially to regional development and job creation. Examples include glass manufacturing in Merseyside and Lancashire, the Welsh steel industry and the gypsum industry in East Leake. The UK also has exceptionally strong R&D capacities, with construction materials companies contributing to and funding the expansion of the UK's knowledge base. These advantages are illustrated in the fact that the UK's construction materials expertise is sought after around the world, particularly in the Middle East. Harnessing existing strengths in materials, minerals and mining will be crucial to the effective delivery of the government's construction aims.

Building homes

The target of building an additional 1.5 million homes in this parliament has the potential to improve the accessibility of housing, while boosting employment opportunities. However, this is an extremely ambitious goal and the full span of the construction supply chain must be strategically supported to make it possible. Moreover, construction rates, which for 2023-24 were under 200,000 new homes per annum[31], will need to be accelerated significantly. A key challenge in this regard will be overcoming skills shortages in the construction sector, including construction materials. The Construction Skills Network estimates that an additional 250,000 workers will be needed in the industry between 2024 and 2028. This includes stonemasons, glass and ceramics makers, metal plate workers, smiths, moulders and woodworkers, as well as materials adjacent skills such as environmental protection, quality assurance and health and safety[32].

One potential avenue for growing workforce capacity is through investment in modern methods of construction (MMC) skills. This includes offsite manufacture and modular construction, prefabrication, preassembly and design. These skills are highly transferrable between construction and manufacturing and so present an important opportunity to develop the talent pool for growth-driving sectors across the economy. MMC have the potential to increase speed and cost efficiency, while reducing waste and resource intensity. As with all forms of construction, materials are the bedrock of MMC, including in the use of timber frames, polymer structural components and precast concrete.

Infrastructure projects

The government has stated that kickstarting growth will require major investment in the infrastructure that supports priority sectors, including transportation networks, broadband connections, gigafactories and data centres. MMC are applicable to large-scale infrastructure projects,

[30] https://www.ciob.org/blog/keeping-sustainable-construction-on-the-agenda

[31] https://www.gov.uk/government/statistics/housing-supply-net-additional-dwellings-england-2023-to-2024/housing-supply-net-additional-dwellings-england-2023-to-2024

[32] https://www.citb.co.uk/media/3j4jj3lo/ctb1003_csn_technical-doc_aw2.pdf

for instance in pre-making sections of concrete tunnels, and should be considered as an important means to increase efficiencies in time, cost and resource use.

Materials, minerals and mining industries will be crucial to the delivery of critical infrastructure at pace. Mineral products such as cement, concrete and asphalt are produced in the UK and are vital inputs in road and highway projects. Similarly, rail infrastructure relies on steel for tracks, metal alloys, composites and plastics for train construction, and copper and aluminium for signalling systems. Across transport sectors, optimising material properties is an avenue to improve fuel efficiency, reduce emissions and enhance safety.

Gigafactories and data centres are similarly dependent on material inputs, both for their construction and operation. The large-scale manufacturing of batteries and other energy storage solutions is not possible without an ongoing supply of critical raw materials such as lithium, cobalt and graphite. Moreover, all batteries need material enclosures, with composites emerging as the material of choice for automotive battery packs. In the construction of data centres, polymers are essential for cable insulation, server components and cooling systems. Their electrical insulating properties and flexibility support the complex wiring and equipment layouts required for data processing.

Managing domestic resources

The construction industry relies heavily on raw and processed materials that are domestically sourced. Indeed, the combined production of aggregates, asphalt, cement, concrete, stone, mortar and silica sand in the UK reaches an estimated output of 419 tonnes per annum[33]. These material supply chains, based on extraction through quarrying and associated secondary sources, are fundamental to the government's construction ambitions and largely dominated by UK industry. However, despite domestic strengths, the mineral supply needed to meet increased construction rates over the coming years cannot be taken for granted.

The replenishment of reserves to maintain outputs over a prolonged period, against the backdrop of a declining landbank, will be a major challenge. There is an ongoing failure to replenish construction aggregate reserves in the UK, placing a significant strain on future availability. According to the Mineral Products Association, the ten-year average replenishment rate is 63% for sand and gravel reserves and only 52% for crushed rock reserves[34]. In addition, as the government strives to increase the pace of construction and infrastructure, the competition for land may encroach on mineral reserves leading to higher rates of sterilisation. These issues require government to adopt a strategic approach to mineral planning, including assessing the impacts of construction on the availability and demand for mineral resources and committing to safeguarding strategic reserves.

Greening construction materials

There is a risk of potential trade-offs between the government's ambitious construction and infrastructure plans and its net zero targets. The construction industry has a major environmental footprint and decisive government action is needed to support decarbonisation and circularity in this sector. Enabling and incentivising sustainable solutions in construction materials from cradle to after end-of-first-life will be essential to minimise environmental compromises and ensure the delivery of green infrastructure at pace.

The shift towards a more circular and resource efficient construction model will be essential in this regard. Given the levels of waste produced by the sector, the repurposing of secondary materials should be considered a critical starting point for reducing the carbon intensity of the government's infrastructure targets. For instance, the use of reclaimed steel has been shown to reduce embodied carbon by over 80% compared to primary sources[35]. Similarly, the reuse of raised access floor panels can lead to up to 82% carbon savings[36]. To facilitate a shift in industrial practices and harness the environmental and economic benefits of secondary resources, the introduction of clear regulatory standards for the use of repurposed materials in construction will be vital.

[33] https://mineralproducts.org/Industry-Overview/Crucial-to-the-Economy.aspx

[34] https://www.mineralproducts.org/News/2023/release12.aspx

[35] Holbein Gardens (DISRUPT) – The Alliance for Sustainable Building Products

[36] rmf_eco_range_1.pdf

With respect to the target of 1.5 million new homes, increased investment in timber framed houses could be of benefit. The use of timber in construction can reduce the whole life carbon impact of our built environment. Where wood is sourced from sustainably managed forests, timber products can act as a carbon store, locking away carbon for the duration of that product's life. The carbon storage for a timber framed home is approximately 50% higher than in masonry homes[37]. While already common in parts of the UK such as Scotland, there is substantial room to grow the use of timber to deliver construction targets. Homegrown timber is sufficiently strong to be used in timber framed houses and mobilising UK industry to source timber domestically will be key to boosting economic activity and fostering sustainable resource management.

In addition, there is a wide array of green innovations and practices that can be harnessed and promoted by government in line with construction targets. This includes new innovations in low carbon cement and admixtures to enable low carbon concrete products, energy efficient glass windows, polymer and composite-based insulation materials to reduce energy demands, the use of recycled composites from other sectors in construction products such as scaffolding and fencing and the application of corrosion-resistant plastics to extend the lifespan of construction materials.

To maximise the benefits of green material solutions for the government's infrastructure and growth targets, it is essential that low carbon construction products are cost competitive. The UK has an excellent research base with significant strengths in the decarbonisation of construction materials. Nevertheless, the application of these innovations in industry is limited by the price premiums associated with greener products. For instance, the UK has made major strides in the development of low embodied carbon architectural glass. However, cheaper, high carbon glass imports continue to dominate the market. The full implementation of the carbon border adjustment mechanism (CBAM), alongside additional incentives for the use of low-carbon materials in construction, will be crucial to addressing these dynamics. Moreover, as the decarbonisation of construction materials largely depends on the switch to electric production processes, combatting high industrial electricity prices will be essential for the delivery of competitive, low-carbon UK products.

3.4 Research and development

> ***"Drive innovation, investment and the adoption of technology to seize the opportunities of a future economy," – Plan for Change***

Across key industries and associated infrastructure, research and development (R&D) is a key driver of growth, leading to increased value creation and high-quality job opportunities. Moreover, advancements in machine learning have enabled AI integrated materials research approaches, with applications across materials design, additive manufacturing, lifecycle analysis and more. As is recognised in the *Plan for Change*, capitalising on the UK's science and research capabilities is essential to boosting growth and raising living standards across the UK. Materials, minerals and mining sectors are key here. As has been highlighted, innovations in material sciences not only add substantially to GDP, but also contribute to enhanced efficiency, sustainability and performance across growth-driving industries.

There are many strengths to build on in this area. The UK is home to world leading universities and research and technology organisations (RTOs), a highly educated workforce, and a depth of materials expertise across both academia and industry. Materials research institutes provide high value-added employment and are a significant source of funding for researchers across the country. For instance, Glass Futures' Global Centre for Excellence explores methods of decarbonising the glass and foundation industries and is a major innovation hub located in the Liverpool city region. Similarly, the London Institute for Healthcare Engineering in Westminster and comparable regional incubators play a key role in facilitating materials innovation for healthcare.

At the same time, there are several barriers to reaching the full potential of materials research and innovation in the UK. The challenging funding environment for academia poses a risk to essential degrees in materials science and engineering.

[37] https://www.gov.uk/government/publications/timber-in-construction-roadmap-2025/timber-in-construction-roadmap-2025#:~:text=At%20the%20individual%20building%20level,(%20CLT%20)%20instead%20of%20concrete.

As these programmes are often equipment heavy, they are more likely to be cut or merged in the face of budgetary restrictions. This has knock-on not only for the pipeline of skilled workers to the labour market, but also for the UK's research capabilities in materials, minerals and mining sectors.

In addition, there are significant challenges in translating the UK's materials research base into economic growth. Key issues include stop-start funding trends, short notices for funding opportunities, long timescales for application assessment processes and a low probability of success for funding applicants. These factors undermine engagement and compromise long term progress in the materials research field. Where top researchers lack good career progression opportunities due to an uncertain funding landscape, there is a risk of brain drain of the UK's best talent.

Another challenge is technological translation from research through to successful, mature companies. This issue begins at the funding stage. There is little prioritisation of initial research projects based on credible routes to exploitation in the UK and there is insufficient scrutiny of end-user engagement and commercialisation plans at these early stages. More strategically directed research funding and the coordination of key players from the entire research and development cycle could play a role in ensuring greater levels of technological translation down the line.

At the development stage, UK innovations are often picked up and commercialised overseas. Current leading UK research on batteries is an example where technology is licensed or small start-ups are acquired in the early phases at relatively low prices and the associated growth opportunities are offshored. One key barrier to development and growth domestically is the so-called 'valley of death' for tech startups at mid-technological readiness level (TRL). After initial funding, start-ups often face a lack of investment or opportunity to scale-up, at which point acquisition by overseas competitors at lower prices may be more likely.

In the current landscape the UK is often seen as a stop off point on the path to a successful materials start-up and not the main attraction. This trend hinders the growth potential associated with the UK's excellent research base and limits the UK's domestic supply of important emerging technologies. Particularly in essential sectors such as healthcare, developing homegrown innovations is an important step to bolster supply security in the face of international political headwinds. A more strategic and enabling funding environment, particularly at mid-TRL level, is needed to enable a thriving innovation sector and maximise domestic value retention. As advances in materials, minerals and mining underpin innovations across a wide range of sectors, these disciplines should be considered a key priority in efforts to advance the UK's research base.

BELL KA PANG/Shutterstock

4.

Making Britian a clean energy superpower

4.1 Clean energy and the materials cycle

Plan for Change Milestone: to secure our energy supply with home-grown, clean power.

The ambition to rapidly grow the UK's clean energy industry is an essential step towards a secure and sustainable economy. However, government policy in this area to date has demonstrated a narrow focus on downstream energy supply chains, such as the assembly, installation and operation of clean energy infrastructure. While vital, these industries alone are not sufficient to ensure sovereign energy capacity in the UK. All energy infrastructure and green technologies rely on the sourcing, processing and engineering of materials. The International Energy Agency estimates that the clean energy investment needed to limit warming to 1.5 degrees will require a 400% increase in critical mineral demand by 2030[38]. These minerals are rarely deployed in their raw form and their utilisation in energy sectors depends on material processing, metallurgy and manufacturing industries.

The delivery of 95% low carbon electricity generation by 2030 is an ambitious target that will depend on a coordinated scaling up of industrial activity across the entire supply chain. To be successful the government must expand its understanding of 'home-grown energy' to include domestic capacity in the materials, minerals and mining sectors and incorporate a strategic focus on materials into its energy mission. The centrality of the materials cycle to clean energy projects is illustrated in the examples below:

Wind

The UK is well positioned to become a pioneer in wind farming, with its island geography and long history of offshore energy infrastructure presenting unique advantages. Both onshore and offshore wind projects rely on huge volumes of metals, minerals and manufactured materials. Most of a wind turbine's mass is made up of steel, cast iron, composites, copper and aluminium[39]. There are an estimated 120 tonnes of steel needed per megawatt of wind capacity[40] and offshore farms require hundreds of kilometres of copper cables. Wind turbine blades are manufactured from composite materials such as glass fibre and carbon fibre, and composites innovation to develop longer, lighter blades is vital to increased efficiency. The advancement of long-life surface coatings to minimise maintenance burdens is also necessary to enhance the cost efficiency of wind farms. Finally, the sourcing and processing of critical materials, including rare earth elements, are essential for permanent magnets used in turbines[41].

Solar

Photovoltaic (PV) solar energy has become one of the cheapest and most significant low carbon energy sources in the UK. The nation's robust solar PV installation industry relies on access to a range of materials. Important feedstocks include high grade glass, plastic encapsulants and back sheet layers to improve longevity, and silicon for the manufacturing of solar cells. Other emerging PV materials such as perovskites and organic PV have a strong UK research base that is already spinning off early industrialisation.

Carbon Capture Utilisation and Storage (CCUS) and Hydrogen

CCUS and hydrogen both have the potential to play an important role in reducing emissions in difficult to abate sectors, such as heavy industry. The scale-up of these technologies will depend on the secure and rapid delivery of necessary material components and innovations. For instance, gaseous hydrogen will require carbon fibre-based storage tanks, particularly for land transportation. Moreover, the engineering of appropriate rubber materials for sealing systems is a necessity for safe storage. Similarly, CCUS will not be possible without the development of advanced material coatings that can withstand corrosion. In both technologies, polymers will be essential for piping and membrane systems due to their chemical resistance and flexibility.

The Grid

The National Energy System Operator (NESO) has stated that 1,000 km of onshore electricity network will be needed to deliver clean power by 2030[42]. This will be a materially intensive process – significant volumes of steel will be needed to construct pylons, composites and ceramics will be essential as insulators for power lines, aluminium and copper will be needed for wiring and cables, and concrete will be required for foundations. NESO has stated that limited access to materials and manufactured parts may present a challenge for the delivery of the mission and, if not addressed, could result in rising imports to meet government targets[43].

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[38] https://www.iea.org/topics/critical-minerals

[39] https://www.nrel.gov/docs/fy17osti/66861.pdf

[40] https://windeurope.org/newsroom/press-releases/ensuring-access-to-critical-materials-for-steel-and-wind-sectors-essential-for-eu-clean-tech-economy/

[41] https://www.iea.org/topics/critical-minerals

[42-43] https://www.neso.energy/document/346651/download

Material circularity

Given the scale of resources involved, the sourcing and management of material flows must be recognised as key to the UK's energy transition. Many of the materials and minerals needed to deliver clean energy are already embodied in end-of-life assets in the UK, including critical raw materials in electric vehicle batteries, large volumes of steel in oil and gas rigs nearing decommissioning and high-quality copper in end-of-life subsea cables. With targeted policy planning and investment, there is the potential to repurpose these resources to deliver the clean energy infrastructure of the future, thus reducing dependence on primary, linear supply chains. Design engineering, recycling and decommissioning sectors will all have a vital role to play in implementing a circular model of the government's clean energy mission.

4.2 Import dependence and the clean energy mission

> ***"We will ensure that we make, build and buy more in Britain" – Plan for Change***

A key goal of the clean energy mission is to ensure a secure power system, insulated from the shocks of volatile international supply chains. The focus in this regard has largely been on moving away from imported energy sources by delivering clean energy infrastructure located in the UK. However, more attention needs to be given to the material inputs required for these projects and the risk of import dependence and environmental offshoring in these industries. As it stands, the majority of materials used in the clean energy sector are imported as intermediary products such as refined minerals, metals and processed materials.

As noted above, the UK imports almost all composite materials, including carbon fibres, significant volumes of glass fibres and most high-performance resins. Despite the huge demand associated with the roll-out of wind farm projects, the small-scale production of carbon fibres in Scotland is under threat. The lack of domestic capacity in this area is a concern, particularly as Chinese demand for these materials is forecast to rise dramatically in the coming years, causing potential hold ups in global supply chains.

These same trends are seen in materials for battery technology. Though crucial for the incorporation of renewables into the grid, almost all batteries are currently imported into the UK. Some progress is being made in this area, with new gigafactories in the planning and certain cells already being manufactured in the Northeast. Nonetheless, the UK's access to critical raw materials used in batteries, such as lithium and cobalt, remains dependent on international supply chains.

The solar industry faces similar challenges. PV panels are primarily imported, with the international market being overwhelmingly concentrated in China. According to the International Energy Agency, China's share in all manufacturing stages of solar panels globally exceeds 80%[44]. While there is some solar panel production in the UK, this remains highly dependent on overseas supply of inputs such as silicon.

The large-scale reliance on imports for clean energy materials leaves the UK open to high and fluctuating costs that could impede the roll-out of affordable clean energy projects. Moreover, the geographical concentration of supply, particularly in the hands of Chinese producers, presents a tangible security challenge. To insulate the UK's energy sector from the severity of supply chain shocks, the government should strive to develop more diverse, transparent and secure trade routes, bolster domestic production and invest in the repurposing and recycling of existing domestic assets.

4.3 Job creation in clean energy materials

> ***"Secure the clean energy jobs and industries of the future"- Plan for Change***

Employment creation across the UK is a key priority within the clean energy mission. The government has described net zero as "one of the economic opportunities of the 21st century"[45] that brings with it a "race for new jobs and industries"[46]. The employment opportunities associated with the transition span across the full supply chain and include high productivity roles in the materials,

[44] https://www.iea.org/reports/solar-pv-global-supply-chains/executive-summary

[45-46] https://www.gov.uk/government/publications/plan-for-change

minerals and mining industries. However, the government's focus thus far has largely been on jobs in the final stages of clean energy projects, such as installation and maintenance. Expanding the definition of clean energy jobs to include employment associated with material inputs and end-of-life management, and providing targeted support for these industries, can help ensure the transition has a net positive impact on employment in the UK.

Employment opportunities

The potential for green job creation is seen across the materials, minerals and mining sectors. For instance, demand for plastic components in wind turbines, solar panels and battery storage systems has led to an increase in new manufacturing jobs, particularly in regions with a focus on rolling out renewable energy. Moreover, innovation in plastic materials, such as developing more efficient photovoltaic cells or more durable turbine blades, has opened up new avenues for high-skilled roles in R&D. Similarly, materials characterisation industries focused on clean energy solutions have driven the creation of quality jobs in research, engineering and manufacturing, as well as indirectly supported downstream employment opportunities in clean energy projects. In the composites sector, additional high value roles are arising due to the growth of wind turbine production and the demand for lightweighting technologies. Finally, the recovery, repurposing and recycling of materials for the energy transition, including through the decommissioning of energy infrastructure, has the potential to be a major source of employment in the UK given the right level of investment.

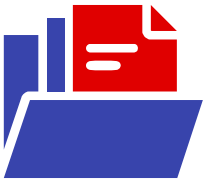
Many of the industries mentioned require a high proportion of skilled labour and thus present an opportunity to upskill existing workforces, raise average worker productivity and contribute to GDP growth. Moreover, by facilitating the roll-out of green infrastructure and technology, these sectors provide the building blocks for employment further down the supply chain. Materials, minerals and mining industries are thus crucial to supplying the next generation of jobs in the UK and ensuring complementarity between the clean energy mission and the government's target to raise living standards in every region of the UK.

Skills challenges

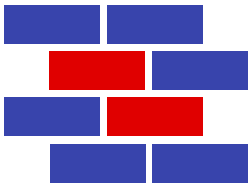
The economic and environmental benefits associated with clean energy cannot be realised without an adequate pipeline of workers to fill emerging roles. Many materials, minerals and mining industries essential to the transition are facing severe and worsening skills gaps. As noted above, the composites sector, vital for the roll-out of renewable energy infrastructure, is facing a shortage of skilled workers at all levels. Similarly, domestic capacity for the production and recovery of strategic materials is compromised by widespread skills challenges in the mining sector, including shortages of exploration geologists, metallurgists and chemical engineers. The elastomers industry, which is necessary for the delivery of safe storage systems for hydrogen, faces a lack of new entrants, with qualified talent often being attracted overseas. The coatings and surface technology sector, crucial for ensuring durable energy infrastructure, has identified high-quality training and education as a key challenge for the coming decade. Finally, the oil and gas decommissioning sectors are facing severe shortages of the practical skills, such as burning and welding, needed to repurpose strategic materials after end-of-life.

As clean energy supply chains depend on skilled labour, these challenges risk undermining the delivery of the UK's energy transition and limiting the opportunities for growth in material industries. Market forces have proven insufficient to address these shortages and targeted government intervention is urgently needed. As a first step, the government can facilitate awareness raising on the role of materials, minerals and mining in achieving the transition to net zero and combat outdated perceptions of these sectors. Additionally, a proactive approach to training and education is needed. This includes promoting careers in clean energy supply chains at primary and secondary schools, supporting the delivery of relevant training programmes at higher education institutes, funding opportunities for reskilling and upskilling and initiatives to support effective workforce transition in line with the shifting energy landscape. Finally, programmes advancing diversity and gender balance across educational levels and career stages can help people from all backgrounds access high-quality work in the clean energy supply chain, thus broadening the labour pool drawn on by materials, minerals and mining employers.

From its foundations to its milestones, the success of the government's *Plan for Change* is dependent on a resilient and thriving materials sector. Securing access to the goods and services that keep our society running, fostering innovation and growth in high value sectors and delivering a sovereign and sustainable energy system –these are all ambitions underpinned by materials, minerals and mining industries. The focus on downstream supply outputs, and the assumption that material challenges will be addressed by end-use sectors, are outdated in the current global market landscape. Proactive action is needed to capture the growth potential of material sectors and responsibly manage the physical resources on which our economy depends. The following areas should be considered:

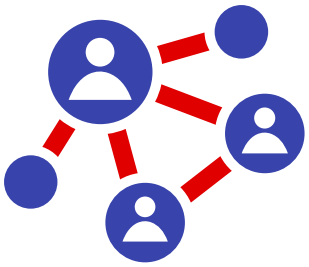


Data gathering: A quantitative assessment should be undertaken to establish the material flows, infrastructure and labour needed to deliver the ambitions of the *Plan for Change*. This investigation should strive to identify both shortages and opportunities for expansion across the full materials cycle, from exploration to end-of-life management. In addition to considering the needs of specific strategic industries, a cross-sectoral, whole-economy approach should be taken to establish the UK's material capabilities and challenges.

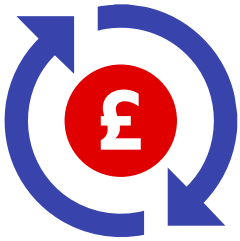


Building domestic capability: Based on quantitative assessments, gaps between forecast demand and UK supply chain capacity should be targeted for intervention. Depending on the needs of industry, beneficial actions may include investment in infrastructure and R&D, strategic industrial planning, increased regulatory clarity and reforms and/or subsidies to reduce energy costs. For some industries, developing secure and sustainable domestic capacity across the supply chain may necessitate the implementation of material specific sector plans under the remit of the Industrial Strategy. These measures should strive to reverse trends towards deindustrialisation and offshoring, while building on the existing strengths of materials, minerals and mining industries in the UK.

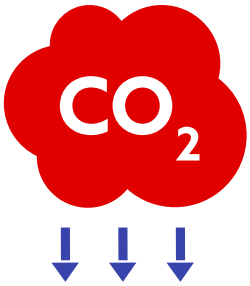
Overcoming skills gaps: Pervasive skills shortages across the materials cycle undermine the delivery of economic growth, the rollout of clean energy and the development of secure, resilient and sustainable supply chains. The ageing workforce in several materials industries, combined with insufficient levels of new entrants, means that more acute challenges are on the horizon if current trends continue. Proactive measures are needed to ensure an adequate pipeline of skilled workers to meet growing demand across strategic industries. This includes setting targets to fill skills gaps in line with job creation; awareness raising at all educational levels; funding for relevant degrees, apprenticeships and upskilling programmes; fiscal incentives for employers to train new staff; and support for workers transitioning from low-carbon to high-carbon sectors.



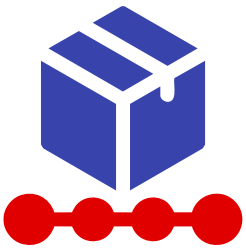
Cross-sector coordination: The successful delivery of the *Plan for Change* will require a coordinated upscaling of operations across a diverse range of materials sectors. To ensure the efficient, responsible and secure management of material flows, the government must implement a cross-industry, cross-departmental National Materials Strategy, building on and expanding the scope of the National Materials Innovation Strategy. This strategy should strive to protect capabilities, supply chains and technologies of strategic importance, ensure coordination between government and industry and create a stable regulatory and standards environment across diverse materials markets. To ensure a comprehensive approach, this strategy must encompass the entire materials cycle, including the management of mineral resources, material processing and manufacturing, materials innovation and engineering and end-of-life management.



Strengthening circularity: The shift towards a resource-efficient and circular economic model can help bolster the security and stability of essential supply chains, drive growth and employment in priority sectors, deliver on the government's infrastructure promises and achieve a resilient clean energy sector. The implementation of the *Plan for Change* should be aligned with and reinforce the Circular Economy Strategy and strive to minimise dependence on unsustainable linear supply chains. Within the framework of the *Plan for Change*, steps should be taken to ensure investment in circular infrastructure and skills and to incentivise the transition away from linear supply chains in strategic industries. This includes using tax incentives to boost scrap collection, capital allowances for machinery to improve advanced sorting and processing domestically and reform to the legal framework surrounding waste to maximise the potential for secondary material use.



Decarbonisation: Due to their energy and resource intensity, many materials, minerals and mining industries are at a high risk of carbon leakage and environmental offshoring. This undermines growth potential, supply security and environmental ambitions, thus posing a threat to core tenants of the *Plan for Change*. As the UK strives to become a global leader on climate, net zero targets and environmental regulations must be matched with extensive investment in the decarbonisation of materials industries. Moreover, measures to address high energy prices in the UK and the full implementation of the carbon border adjustment mechanism are needed to ensure that low carbon materials produced domestically remain competitive against imports and on the global market.



A full supply chain approach: To achieve government's ambitions, the entire materials cycle must be considered in the implementation of the *Plan for Change*. With respect to the foundations, this means adopting a more comprehensive understanding of security and stability and ensuring that questions of material flows are built into policy development surrounding geopolitics, defence and macroeconomic planning. In relation to the growth mission, there is a need to recognise that material, minerals and mining industries are not only inputs into vital sectors, but are also important drivers of growth, employment and investment across the UK economy. For the clean energy mission, there must be an understanding that without the secure and responsible management of materials, domestic clean energy infrastructure will be vulnerable to many of the same shocks that the government is seeking to create a buffer against.

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