IOM3 Submission: Plan for Steel Consultation

The Institute of Materials, Minerals & Mining (IOM3) is a professional engineering, environmental and scientific institution, a registered charity and governed by a Royal Charter. IOM3 supports professionals in materials, minerals, mining and associated technical disciplines to be champions of the transition to a low-carbon, resilient & resource efficient society. With around 15,000 members, IOM3 brings together expertise across the full materials cycle.

This submission has been informed by the expertise and experience of IOM3 members including significant input from the IOM3 Iron & Steel Group.

1. What are the strengths of the UK steel sector and the biggest challenges it faces?

The UK steel industry is an integral part of the modern economy. It underpins the country's manufacturing sector, has important implications for defence, and plays a vital role in the low-carbon transition and clean energy infrastructure. At the same time, the steel industry is a significant contributor to emissions.

UK steel is a small, but well-connected and experienced industrial community. As many of the current companies used to be part of the same larger company, there is little direct competition between them. Driving sustainability, investing in technology and skills, and seizing opportunities in infrastructure development will be vital for the industry's growth and competitiveness in the evolving market.

The are a number of strengths of the UK steel sector. Firstly, the UK has world-leading expertise in steel research, development and innovation and a good level of technological translation from knowledge produced in universities and research institutions through to products on the market. Alongside advances in steel production, there is significant potential in the UK for innovation in making the best use of steel across all its applications. Particular strengths across research, development and innovation include the development of new grades for specialty applications, electric arc furnace (EAF) steelmaking, understanding of tramp elements and circularity, as well as considerable expertise in finishing/coating technologies for specialist applications.

The rapid pace of technological progress in steel, originating both in the UK and elsewhere, will present exciting opportunities for the sector over the coming years. Automation, artificial intelligence, and data analytics are set to revolutionise manufacturing processes, improve productivity, and reduce costs. By building on current use and further embracing industry 4.0 technologies, the UK can enhance its steel manufacturing capabilities and maintain an edge in the increasingly competitive global market. Key opportunities include digitalisation to enable circularity, novel development and processing innovations, as well as digital passporting and advanced traceability.

In light of the transition to net zero and the imperative to increase resource efficiency and circularity, the UK's progress on green steel is an important strength. In particular, the government's decision to support the shift from blast furnaces to EAFs presents major opportunities. EAFs are essential to ensure the value of steel in the transition to a more sustainable economy and are positioned to become a core steel technology world-wide. A

further shift to high volume EAF is a great opportunity for the UK to lead on scrap-based steelmaking, opening up a wide array of innovation potential including in sorting, separating and cleaning scrap feedstock, in novel processing to control alloy quality in the melt, developing world-leading expertise in the management of residual and tramp elements, and innovation in downstream component manufacture.

The UK's availability of scrap is a strength, however, there are associated challenges regarding quality and supply chains. Once operational in 2027/28, the planned UK EAFs will have a ~5mt/yr demand for high quality steel feedstock; however, most recycled steel produced today in the UK is Heavy Melting Scrap (HMS). HMS is made by shearing material rather than shredding and is then processed in UK or overseas to typically make lower value steel, such as reinforcing bar, which is less sensitive to impurities and chemistry.

The UK has great strength in production of high-quality specialist products such as for the nuclear, defence, aerospace and automotive sectors. This already includes the use of EAF (albeit using low-residual, highly separated and sorted scrap at present).

Despite these advantages, there are also major challenges facing the domestic steel industry that could threaten the viability of the industry. One of the most significant is the cost of operations in the UK, including in relation to energy, which can be prohibitive for steel manufacturers. High and unpredictable electricity prices present a major barrier to sustained investment in EAFs in particular and risk undermining the UK's progress in the transition to green steel.

Decades of low investment, resulting in part from low capital expenditure associated with high costs, is also a concern. Ongoing investment challenges have culminated in a period of upheaval for the UK steel sector, as classic heavy end and rolling capacity across the country is heading towards end of life. For a thriving and competitive steel sector these trends must be reversed. This will require a systemic review of the product capabilities the UK seeks to grow and mobilising significant investment towards these areas.

Another challenge is strong competition from steel suppliers in the US, Japan, Europe, China and India. During 1980-2000 countries such as Japan were leading steel grade innovators particularly within the automotive and shipping sectors, as well as developing new rolling technologies and EAFs. This was also influenced (and still is) by the high cost and limited availability of energy, pushing steelmakers to adopt to use lower reheating temperatures in their furnaces and also developing new rolling and cooling technologies on strip and plate mills. However, as the industry matured and demand for domestic steel saturated, Japan increasingly and successfully moved to a strategy of overseas partnerships. For example, from 2000, individual Japanese steelmakers entered into technical agreements with all of the main Indian steelmakers to support production of high value cold rolled and coated products. Today, there is a similar move from China where large steelmakers are creating joint-ventures and even overseas investment especially into Southeast Asia to the extent of destabilising the existing indigenous players and market. Furthermore, the majority of the investments have been adding new blast furnaces rather than EAFs. Also in China, steel demand is expected to continuously decline to 700-750mt by circa 2050 from its current 1.05bnt. However, Chinese steelmakers will export its plate, strip

and long products and last year exported 110mt of steel globally. With the passage of time, a growing portion of exports will be higher value steel grades and/or products. Currently, China has the highest number of Endless Strip Processing (ESP) lines in the world (the first was developed and installed by Arvedi in Italy, but it took 20 years for it to be adopted by the industry), and this allows for low-cost high-volume production of hot rolled strip. Crucially, this technology allows for a smaller site footprint, can run via scrap EAF and is capable of producing hot rolled strip at gauges at 0.8mm thick, thus being able to substitute several cold rolled steel grades and save significant cost. Currently, the hot strip mill at Port Talbot can only roll down to 1.4 to 1.5mm in thickness. Hence, the UK could become exposed to such material quite easily.

In addition, in many countries the carbon intensity of steel production is higher than in the UK, meaning there is a risk of environmental offshoring associated with imports. Decisive action, including the full implementation of the carbon border adjustment mechanism (CBAM) in lock-step with the EU's implementation timeframe, is needed to avoid carbon leakage, carbon dumping and to ensure that the UK remains competitive in the transition to net zero. Moreover, developing niche markets and specialised products, as well as focusing on quality assurance and customer service, can help differentiate UK steel from its competitors and create a competitive advantage.

Skills shortages are another key issue for the steel industry. Outdated public perceptions of steel mean that it is difficult to attract younger generations to a career in the sector, resulting in an ageing workforce. There is an insufficient pipeline of skilled metallurgists which will present major challenges for the growth of the industry and innovation of new steels in the coming years.

The UK's changing regulatory landscape also presents challenges for the steel industry. Evolving regulations such as those associated with environmental standards, emissions reductions targets and trade policies require significant focus and resource. Whilst important to deliver the change required, navigating the transitions can be challenging and onerous. The industry must remain compliant with regulations while finding innovative ways to minimise the associated costs and maintain competitiveness. The government can support this by providing long term certainty and predictability on the direction of policy. The steel strategy is an important step in this regard and should be implemented in dialogue with the government's industrial strategy and broader green growth ambitions to ensure consistency and clarity.

Overall, the steel sector is facing a period of change that presents both opportunities and challenges. The move towards decarbonised and circular production processes, the rise of low-cost steel manufacturing in emerging economies, the rapid pace of technological change and an evolving regulatory environment all mean there is significant pressure to adapt and innovate. The government can support the steel sector to seize these opportunities and enhance competitiveness by providing long term certainty and clarity and targeted support, including in relation to research and development, operation costs, infrastructure for the green transition and trade policies.

2. What do we need to have achieved in 5 years' time to be on track to deliver a successful and competitive steel sector in 2035, and what does this look like?

For the UK steel sector to thrive, regulatory and policy stability is needed. The development of the UK steel strategy is a welcome step as it sends clear market signals to businesses and investors on the intentions of government. Due to it's strategic importance, this must not be a one-off event but an ongoing commitment that is renewed at regular intervals. For example, China and India have a rolling 5-year plan published via a dedicated body.

In a rapidly changing industrial landscape, understanding and strategically planning what steelmaking in the UK will look like over the next decade will be crucial to the success of these policies. The rapid increase in direct reduction and EAF steelmaking have already shifted the landscape of this industry and further developments associated with the potential role of hydrogen and novel technologies could take place over the coming years.

A forward-looking approach from government is needed to ensure that the UK is well positioned to take advantage of the transition to green steel and is recognised as a competitive location for production today and in the future. Further progress of EAF scrap-based steelmaking for grades previously manufactured by the blast furnace-basic oxygen steelmaking route, both in terms of skills and manufacturing capability, will be required. This includes new research and expertise at universities, catapults and RTOs with substantial involvement from industrial partners. Despite only having a relatively small steel output versus other nations, the UK still has the basis to become a leading research hub for global steelmakers based on the current talent pool. However, this is at risk if there is insufficient demand.

From the foundation of effective strategic planning, the government must take targeted and proactive measures to address ongoing underinvestment in capital expenditure for the steel industry. A long-term investment plan is needed for British infrastructure, including in the areas of defence, net zero and transportation, with a strategic approach to steel at its heart to ensure the economic viability of sourcing steel domestically. Capital investment in downstream plant such as casting, forming and finishing operations as well as specialist manufacturing is required to ensure capacity to fulfil future demand. Large publicly backed infrastructure projects, including those that fall under the remit of the industrial strategy, provide the certainty and confidence needed to attract investment to the steel sector.

A plan for skills and training is also necessary as the industry faces an aging workforce and a reduction in qualified workforce. The correct level and type of training for the current and future workforce as well as a plan for knowledge retention from retirees is needed. Government investment in apprenticeship programs, vocational training, and upskilling and reskilling initiatives will be crucial to attract and retain the skilled workforce needed to deliver a competitive steel industry. Alongside this, efforts to improve the visibility and perception of the industry would be beneficial, for example through diverse representation of the roles available and the contribution they make to society and the transition to net zero.

Finally, lower cost and more stable clean energy pricing is essential to ensure a competitive steel industry and enable the sector to transition to lower carbon and more circular production practices. This will require extending existing price guarantee programmes and funding

mechanisms to steelmakers investing in on-site clean energy generation and off-site Power Purchasing Agreements, as discussed in response to Q6.

3. Which UK regions could benefit the most from the improvements in the UK steel industry, and which could feasibly capitalise on future opportunities in the sector, and why?

Building on existing regional strengths across the UK will be essential to the success of the steel strategy. The existing industrial base in Wales, Teeside and South Yorkshire are areas well placed to further realise opportunities rapidly with an existing skills base, regional programmes and interest in further growth. Areas where there is easy access to clean energy sources would be advantageous including for new disruptive technologies to be established in the UK.

What is needed to increase capacity and its location in relation to the market should be considered. For instance, the government could consider:

- Mobilising investment to increase steel plate mill capacity in the North/Scotland. Moreover, taking advantage of localised opportunities associated with the energy transition and the shift towards circularity can bolster the regional strength of the steel industry while also minimising the social cost of the transition for communities. For instance, the installation of plate capacity at Port Talbot steelworks could potentially support the development of floating offshore wind in the Celtic Sea
- Steel plate capacity for nuclear and wind energy projects could potentially be driven by smaller bespoke EAF minimills located close to existing plants or at the site of wind turbine manufacturing rather than at larger centralised plants. Often due to centralisation, the fixed costs of running such a large capacity plant at lower utilisation causes significant financial stress. Smaller, more dynamic capacity has the potential to relieve this, with plants able to be turned on and off as required. This would need to be considered, however, alongside the investment requirements and planned future demand for nuclear and wind energy build timelines.
- The development of steel scrap management and recycling hubs in strategic locations should be encouraged. This could include in Scotland where the decommissioning of oil and gas rigs will be a major source of scrap, and in the midlands coinciding with centres for automotive OEMs with distribution to the various manufacturing assets in Sheffield, Scunthorpe, Humber & South Wales. Consideration should also include how this links into transport infrastructure (supply chains) for the scrap to feed into EAF.
- There are a range of novel technologies coming to market which have the potential to meet the UK Pig iron requirements using legacy waste materials. Rotary Hearth plants could be utilised to extract zinc from ferrous bearing waste from both EAF dust and legacy basic oxygen furnace (BOF) and blast furnace (BF) dusts. Centralising these plants for example in Port Talbot, on the old heavy end, could provide the UK an opportunity to be the recycling hub for the Atlantic Seaboard, with BF and BOS dusts from the EU being utilised to produce High Metallised Briquettes that can feed into the UK EAFs for products where residuals are a concern. Generally, these will also have low residuals as residuals remain in the hot metal rather than be segregated into waste dusts.

4. What can the steel sector do to support the wider growth objectives of the industrial strategy?

The UK steel strategy is a vital input into several of the growth driving sectors identified in the industrial strategy including advanced manufacturing, defence, and clean energy industries. Providing sustainable high-quality products for downstream application and use will help to fulfil sustainable growth ambitions across a range of sectors. Moreover, the sector is itself of vital strategic and economic importance. As noted in the consultation document, a competitive steel industry has the capacity to drive regional development and high-quality employment throughout the UK. Taking advantage of opportunities for growth and supporting value-adding technological advancements in this sector should be considered a key priority in the delivery of the industrial strategy.

For instance, recent strides have been made in the integration of cement production with EAFs, co-producing recycled, low-carbon cement alongside steel. The joining of these two industries ultimately strengthens the steel sector by maximising efficiency and circularity in the production process. The use of recycled portland cement as a flux for electric steel recycling has been commercialised in UK facilities. To harness the benefits for steel in this area, the UK should strive to:

- Maximise the value delivered from EAF installations by exploiting both the steel and byproducts such as slags in the highest value applications available.
- Engage with the wider value chain to unlock new opportunities in upstream waste recycling and better serve downstream customers' requirements.
- Commit to the risk appetite and resources required to enable such innovations.
- Engage with the full value chain from aggregates players to construction customers, creating a new circular proposition working directly with end product users.

In addition to advances in steel production, there is significant opportunity for growth through greater integration with downstream forming and fabrication processes. The more the steel sector can become involved with the design and manufacture of components, the more it will be able to contribute to delivering material efficiency, creating greater value for less steel. One example is drop-in tooling for press lines which has the potential to reduce the automotive sector's scrap metal rates by 75%.

The energy transition will fundamentally rely on steelmaking. For example, wind turbines, solar panels, small modular reactors, nuclear fission and fusion, and delivering green hydrogen all rely on and require steel. Synergistic development of grades, derisking scale up and managing supply chains will therefore be critical to the transition.

Overall, the government should seek to incentivise the steel industry to embrace forthcoming changes in relation to the production, use and recycling of steel products. The widespread adoption of new technologies for decarbonisation and resource efficiency will be essential to foster a sustainable and internationally competitive steel sector and support the wider growth objectives of the industrial strategy.

5. What are the main financing gaps in the UK steel market?

EAF operations face major financial barriers in upgrading facilities and securing long-term power contracts at competitive prices. Without cheaper and more stable clean energy pricing, UK plants will struggle to compete in the wider EU market. UK energy prices remain significantly higher than pre-crisis levels, with adverse effects for energy-intensive industries such as steelmaking. Indeed, despite progress, UK steelmakers are still paying up to 50% more for electricity than their competitors in France and Germany. In addition, access to capital for ancillary electrification and heat recapture projects remains limited, with adverse effects on the transition to fully sustainable steel production.

From the perspective of scrap feedstock for EAFs, immediate and large-scale investment in upstream processing to produce higher quality feedstocks necessary to meet demand is required. This includes sorting facilities, central hubs and transport links. Government support is needed to derisk these investments for private capital, for example through the provision of government backed loans. This will also ensure the lowest carbon footprint of UK produced steel. Otherwise, the UK will continue to export poor quality scrap and need to import higher quality feedstock from other countries to feed our EAFs.

To some extent, there is a gap around available flexible infrastructure to realise and translate innovating research and funding for innovation in itself such as investment in digitalisation, materials 4.0, sensing technologies, infrastructure for digital passports and tracing, recycling opportunities and process optimisation. Funding for fundamental research to support progress will be key. It has been proven that steel-oriented fundamental research can compete against other sectors in open UKRI calls. Translational demonstrator funding is also required, particularly in the shorter term, with joint ventures between energy generation companies and steelmaking to derisk and deliver initiatives that see steels as an enabler. At the industrial level, funding will be required to support challenge-led programmes and drive technologies through upper TRLs.

A lack of funding is leading to a loss of steel expertise including through retirement and university recruitment freezes. Stimulating steel-specific investment streams will help support the researchers that remain and help make the case to UK universities that the area remains research rich. In addition, materials science and engineering undergraduate degrees have suffered from a reduction in demand as well as dwindling post-graduate programmes with steel/metallurgy/manufacturing emphasis.

Finally, for some steel manufacturers the demand for low volumes of steel per order presents a financial challenge. For instance, customers may require as little as one to two tonnes of steel, including in grades that are widely obsolete. The demand for low volumes of legacy grade steel impacts cost efficiency and can make the use of electric arc air melting non-economical. In recent years, these concerns have led to a growing interest in the qualification of primary vacuum-induced melting as an alternative to the primary air melt route historically used for legacy grades. However, this substitution is not straightforward and there are significant costs associated with qualification. Areas of national strategic need should be identified for government intervention, including funding for existing speciality steel suppliers to work with customers to qualify more economical routes.

6. What funding or financing mechanisms are required to fill these gaps and support investment in the UK? What evidence do you have to support your answer, and does the funding mechanism required change depending on the type of investment?

There is significant potential to provide funding for the use of clean energy in UK steelmaking for both onsite energy generation and offsite Power Purchase Agreements (PPAs):

- The Contracts for Difference (CfD) scheme, which guarantees a stable electricity price for renewables, could be expanded to include industrial decarbonisation projects where steelmakers invest in renewables or long-term PPAs. CfD has already been successful in driving down costs in areas such as offshore wind and so could play an important role in overcoming the challenges associated with the energy prices in steel.
- The Industrial Energy Transformation Fund (IETF), which currently provides £315m to energy-intensive industries for efficiency improvements, should be expanded to support clean energy infrastructure directly at steel plants. By supporting energy efficiency gains in steel production, the IETF could bolster the international competitiveness of the sector.
- There is scope for the National Wealth Fund to offer low-cost loans or blended finance mechanisms to incentivise steelmakers to invest in on-site renewables. Similar schemes in Germany (KfW) and Canada (Green Industrial Strategy Fund) have effectively supported industrial decarbonisation.

In addition to supporting the widespread deployment of clean energy in steelmaking, there is a need for funding for capital expenditure for new furnaces, infrastructure upgrades, and scrap supply chain improvements. For example:

- A dedicated steel decarbonisation fund, offering capital grants to support EAF deployment, would help to de-risk the green transition in steel. The Net Zero Industry Act in the EU and the Inflation Reduction Act in the US both provide direct grants for EAF adoption and have been successful in attracting major investment.
- Blended finance models where the National Wealth Fund co-invests with private steelmakers would unlock additional funding. The potential of these kinds of initiatives is illustrated in the Hybrit project in Sweden, which enabled one of the world's first fossil-free steel production projects, backed by public-private co-investment.
- The CBAM revenue allocation is also crucial. When the UK introduces its CBAM in 2027, revenue from import tariffs on high-carbon steel could be used to fund UK EAF investments. The CBAM should also be extended from raw steel to include steel-intensive products, thus maximising the incentives to onshore downstream production in the UK.
- Financing for circular economy infrastructure such as scrap steel collection and advanced sorting technology would improve the economic viability of EAFs. This could take the form of tax breaks or investment allowances to incentivise the development of necessary projects. In Japan, steel recycling programmes backed by the Ministry of Economy, Trade and Industry have been successful in enhancing steel scrap supply and reducing reliance on imported iron ore.

7. How important is funding or financing for supporting investment in the UK, as compared to changes to the policy environment?

Both sufficient financing and an enabling policy environment will be essential to ensuring a thriving and competitive steel industry. Funding and financing for supporting investment in the UK is particularly important with uncertainty in the US and growing dominance in steel supply from Asia. Given the low margins in steelmaking, the importance of funding cannot be underestimated. Following years of underinvestment, it is unlikely that steelmakers will be able to internally finance the level and pace of innovation required to make the UK internationally competitive. Supporting revenue generating opportunities that are cost-efficient upfront can help alleviate funding constraints. Government support is particularly important for start-ups developing essential innovations in steelmaking, as these companies can struggle to establish partnerships with producers. The first user of a new materially efficient approach faces many hurdles and public financing mechanisms could help reduce these risks. Furthermore, it should be recognised that there is already significant research and innovation happening around the world in green steel technologies able to develop and use "low quality" raw materials and re-use via the circular economy. There are therefore opportunities in attracting inward investment for next stage scalable demonstrator projects and beyond. The UK should seek to attract existing disruptive technology enterprises to invest their next step in the UK.

8. What is your view of the future of the UK's steel needs? What developments could increase or decrease future demand by sector and product?

The UK's demand for steel is likely to increase in the coming years in line with the growth of steel dependent sectors. Advanced, high-strength steel for transportation, infrastructure, renewable energy and defence applications will be particularly important. The growth of the offshore and onshore wind sector in the UK, alongside the increase in infrastructure and defence spending, will drive greater demand for high-strength steel plate products. Moreover, increasing electrification and the growth of the electric vehicles (EVs) market will require greater steel output to support the development of the grid network. Moreover, as EVs are generally heavier vehicles, higher strength steels will be required for carparks with increased load bearing capability and more durable crash-barriers for motorways. A gap analysis should be conducted to help identify if there is a strategic need for electrical steels for net zero as domestic production has been lost.

More broadly, because steel is a crucial input across a wide array of industries, it is not always possible to foresee developments that may cause surges in demand. For instance, new green technologies are continuously being developed and commercialised and many will require steel for their delivery. Steel is a highly strategic material and there is thus an imperative to increase domestic capacity both to meet forecasted demand and ensure resilience to unanticipated demand spikes.

9. What are the main barriers to sourcing steel requirements from UK producers (for example: capability, price, service)?

Within the UK there is limited capacity and capability to produce steel plate products of the thicknesses, widths and grades required for infrastructure such as standard oil and gas pipelines and offshore wind turbines. There is a high level of import dependence for these intermediate

steel products. Moreover, domestic capability to produce high strength steel H-beams used in construction is limited. While these products can feasibly be made to the necessary grade in the UK, production is not cost competitive and the beams produced are highly alloyed when compared to global market leaders. Moreover, there are only three major steel fabrication yards in the UK, which imposes limits on the level of steel construction products that can be delivered per year. As such, many high-rise buildings constructed in the UK over the last decade have relied on imported beams.

10. In addition to current and ongoing work, such as the Procurement Act, how can UK government ensure procurement policies, or procurement within government supported projects, promote the use of UK-made steel across the whole supply chain? How does this differ if steel is embedded in other products?

There are several steps that can be taken to promote the use of UK steel through government procurement policies. First and foremost, the government should establish a minimum UK content requirement for steel used in major government backed projects where there is UK capability and capacity to make the relevant products. In line with this, a transparent reporting mechanism is needed to ensure that suppliers disclose the origin of steel used in public contracts. This should include a process to flag where steel originally produced in the UK has been exported in its raw form and then imported back as an intermediate product. It may be valuable to consider some form of tariff reduction in these instances.

To maximise the use of UK steel it is vital to link procurement policies and national infrastructure strategies, ensuring that the prioritisation of domestically produced steel is integrated into government plans for projects such as HS2, offshore wind farms and defence contracts. In addition to minimum quotas, the government could introduce incentives for Tier 1 contractors to use steel sourced in the UK, such as tax breaks or subsidies.

Moreover, in line with the government's net zero targets, there is scope to prioritise green steel products in procurement processes. This could include providing preferential procurement terms for steel with low carbon credentials and steel produced using circular and resource efficient production models. With the necessary transparency and traceability mechanisms, these terms could also be extended to embedded products. There is also an opportunity to work with end users and their customers to promote where the steel used comes from.

In supporting the use of domestically sourced steel, the government should also be conscious that some level of reliance on imports is inevitable. To meet the entirety of UK demand across all grades would require the domestic steel industry to be over-sized and therefore highly vulnerable to shifts in demand. This is neither a desirable nor a practicable outcome. As such, secure and transparent steel supply chains over the long term are required, including reliable sources of low-carbon steel overseas.

11. How can UK government and the UK's steel sector promote the use of UK-made steel in the private sectors that use large quantities of steel?

12. What evidence can you share to highlight the planning, grid and site availability challenges outlined in this section?

13. What UK government policy solutions could best address challenges related to planning, grid and site availability for steel sector investments?

14. What actions should UK government take to encourage more domestic processing of end-of- life vehicles, or encourage stronger circularity of domestic scrap flows, either within the scrap industry or within vertically integrated steel businesses?

The UK must begin to recognise scrap steel as a strategic resource. Several countries around the world have already placed restrictions on the volume of scrap that can be exported, signalling the value of these materials in the global context. Protecting scrap resources also means encouraging and facilitating the timely recycling of steel at the quality required so that the maximum volume of material can remain in circulation at its highest possible value.

The shift towards EAFs will trigger an increased demand for scrap and the commercial incentives associated with these trends will likely lead to stronger circularity of domestic scrap flows. Nevertheless, as other countries make the switch to EAFs, the competition for used metals will intensify and the UK's access to necessary scrap feedstocks cannot be taken for granted. Due to high energy costs, waste disposal costs, transport challenges and environmental regulations, it is currently more profitable for UK companies to export low grade metal scrap than to recycle it domestically. There is also a need to crack down on waste fraud. As shredder waste is now classified as hazardous, albeit with derogation in place to dispose at non-hazardous landfill, there is an even greater incentive to engage in waste fraud than before, due to the higher cost of disposal for hazardous waste.

The feedstock for EAFs in the UK is primarily imported, which is problematic from the perspectives of cost, sustainability and resilience. The standards and grading used to sort scrap steel in the UK must be sufficient to provide the quality and consistency of material required to be effectively and efficiently recycled into high steel grades. Focus on chemistry requirements can help to improve this. In addition, advanced sorting technologies and monitoring tools can help to improve the quality of scrap supply. Greater cooperation along the supply chain, for example creating and improving collaborations between steel manufacturers and scrap suppliers is required to facilitate the change and the transition required. Recognising and exploiting more circular and closed loop supply chains presents a further opportunity and some steel companies are now making direct links with organisations such as those in demolition to ensure a more consistent supply of scrap steel. Another avenue that should be pursued is maximising decommissioned renewables assets as material banks.

Alongside sourcing and processing, efficient transport of the material is required to facilitate a greater domestic use of UK scrap steel. The insufficient number of freight trains and drivers available can impede transport even where the rail network is in place.

The government must take a proactive approach to address these challenges, ensuring that the steel strategy is aligned with and mutually reinforces the government's circular economy strategy. Significant investment in infrastructure will be needed, including regional recycling centres capable of recovering steel from end-of-life vehicles and other sources. Collaboration through the supply chain should be encouraged and an enabling regulatory and fiscal environment to incentivise circularity should be created. This means improving scrap collection

through tax incentives, minimum quality standards for exports and capital allowances for processing machinery. In addition, the government should support the development of design principles and standards to maximise the potential for steel recovery at end-of-life.

Finally, the government should support opportunities for research, development and innovation in scrap processing, including in areas such as refining or re-inventing the shredding process and controlling the alloy content of EAF steel. For instance, in Rotherham, Liberty Speciality Steels have succeeded in producing aerospace grade steel from EAFs, however this has relied on slow and expensive Vacuum-Arc Remelting processes to do so. Innovations to re-invent this process for higher throughput would increase the demand for scrap collection, thus incentivising greater circularity in the steel sector.

15. How important is innovation in developing new processing systems, extracting residuals or designing more tolerant steel products?

Innovation is key to developing these areas, with significant strengths to build on in UK industry. There are numerous excellent examples of innovation at universities that have led (or could lead) to new commercialised steels. For example, steel mechanical properties have traditionally been met by adding various strengthening and refining alloying elements, but the same response has been developed through rapid alloying research and the use of different blends.

Steel and cement co-production technology developed in the UK extracts more residual phosphorus than conventional steelmaking and has prompted the development of new operating protocols for EAFs and slag processing to create higher value materials. More broadly, the shift to EAFs in the UK is creating the demand for new innovations, for example in the collection, recovery and reuse of zinc dust from the furnace.

Innovation in steel is also crucial to meet the needs of other sectors as they evolve. For instance, the requirements of fusion energy mean a whole new family of steels need to be developed in order to meet the tolerances required for higher temperature environments and improve efficiency. As such, a key area of focus for the UK steel sector must be the development of more tolerant steel products. Several countries have invested heavily in new systems in this area and the UK is at risk of falling behind.

With regard to extracting residuals, the industry has traditionally focused on defining the chemical composition of steel grades and producing the cleanest steel for a given product. This has primarily been driven by the automotives and linepipe sectors. Whilst the focus has remained on trying to reduce or eliminate certain residuals, there has been less research on what residuals can be tolerated. There may be opportunities for innovation in this area that are currently underexplored. For instance, recent developments in steel production and rolling technologies such as Endless Strip Production (ESP) have demonstrated that copper can be tolerated.

Every effort should be made now to prevent residual levels increasing in current and future scrap supplies. Options to be considered include rigorous sorting and segregation of scrap down to grade level including residual content, and the manufacture of steel from scrap that is similar in composition and residual level (manufacture like from like) hence utilising the beneficial residuals.

Building on past successes, consideration must be given to the ability to scale up and industrialise new innovations and a strategic approach to assets that are available across multiple research groups in the UK would be beneficial.

16. Which international markets do you see as having the greatest opportunity for UK steel exports?

North America, the EU, the Middle East and some parts of Southeast Asia present good opportunities for UK steel exports. To take advantage of these markets, the UK must identify the specific products in demand by trading partners in these regions and assess this list against domestic capabilities. While North America consumes only a small volume of UK steel exports, their low capacity for tin plate production creates an opportunity for UK industries. In the EU, steel demand is largely associated with hot rolled coil (HRC/ strip) grades for automotive and transportation industries. In the Middle East and Southeast Asia, export opportunities are primarily associated with structural tubes, welded pipe and sections.

The capacity of the current UK steel industry to take advantage of these opportunities is mixed. On the one hand, the UK is home to one of the world's leading pipe mills in Hartlepool, which supplies a large volume of high value subsea gas pipelines. However, the steel plates are largely imported to the UK. As noted previously, there is limited domestic capability in plate mill rolling. Growing the UK's capacity in this area would have the potential to feed into exports in piping, construction, shipbuilding, defence applications and wind turbines. This would require significant capital investment.

Another challenge is producing high strength H-beams at an internationally competitive price. In particular, without necessary investment to support the installation of a Quench and Self-Tempered (QST) cooling unit, the UK's H-beam rolling mill in Scunthorpe will not be able to compete with the Histar steel produced in Luxembourg, which is also now being replicated by mills in China and the Middle East. Currently as Scunthorpe does not have this cooling capability larger amounts of alloying needs to be added to make higher strength S460 and above H-beams which not only makes them expensive to produce, they are more challenging to produce and also will have poorer weldability and low temperature impact performance. Mills like ArcelorMittal's H-Beam facility in Luxembourg is the market leader in S460 Heavy, Jumbo and Super Jumbo H-Beams using QST. This steel product has been extensively used in London for most of the recent tall buildings as well as other large infrastructure projects such as bridge constructions. There are only a handful of mills that are trying to compete with Differdange, which has its own limited capacity to produce. Hence not having such capability undermines the potential for UK steel to take advantage of export opportunities.

17. What are the most significant barriers to exporting for businesses in the steel sector, and how can UK government support businesses to overcome these (including through financing for UK exporters)?

18. What do you want to see in terms of long-term trade protection against overcapacity for the steel sector, and how should the UK respond to any impacts from other nations' responses?

A key challenge with regard to overcapacity is the risk of overseas competitors dumping low-cost products on the UK market. To address this, the UK needs to be closely monitoring industrial developments in China, Southeast Asia and Turkey and have the flexibility to respond rapidly with appropriate mechanisms. For example, as China's domestic steel consumption is due to decline steadily over the coming years and instruments such as the carbon border adjustment mechanism reduce demand for Chinese exports, overcapacity in China's steel industry is highly likely. The country is already responding to these challenges by investing heavily in Southeast Asia, distorting local markets and supply chains in the process. Moreover, China is adapting domestic steel specifications to align with British Standards, making it easier for Chinese steel producers to respond quickly to global market conditions. In this landscape, the threat of dumping of steel products from China is a major concern.

19. Are there particular steel products, originating from particular countries, that are of concern to the UK steel industry, and how, if at all, are these expected to change in the next 5 and 10 years?

A major challenge for the UK steel sector today and over the coming years is the threat of low-cost imports from China. As noted in response to Q18, this is a result of overcapacity in the Chinese steel industry. Last year China exported 110mt of steel due to slow domestic demand, primarily associated with a downturn in the construction industry, which is likely to further decline in the coming decade. It is anticipated that Chinese domestic steel demand will steadily decline from 1050mt to 850 – 900mt in the next 10 years. At the same time, investment in replacing old steel units since 2015 means that the average age of steel assets is low, and most are expected to be operational for well over ten years. China is expanding its capability in all types of steel, in particular heavy and jumbo H-beam, plate mills and Endless Strip Production (ESP) lines for hot rolled coil HRC. Chinese manufacturers have the ability to produce 0.7mm thick HRC, which will displace some cold rolled grades. Today, the top 20 Chinese steel producers account for nearly 30% of global steel output and the Chinese Ministry of Industry has indicated their desire that China's top ten steel producers should aim to hold 60-70% of its domestic industry capacity. This would bring significant global market and economic power to a handful of newly created steel giants.

Strategic investment in UK steel capabilities is essential to begin to protect the market from the threat of highly competitive Chinese imports.

20. How do electricity prices impact your business and investment decisions?

Electricity pricing is a major consideration for steel producers both in terms of day-to-day operations and long-term investment decisions. This is particularly true for EAFs where the cost of electricity is a significant part of the production cost. This can lead to ceasing of operations at times in winter when electricity prices run too high, and production is less economically viable. This is a major barrier to the development of a thriving and competitive steel sector.

From the perspective of innovators working on decarbonisation and resource efficiency, collaboration with steel companies that have unpredictable shutdowns is prohibitive to rapid progress and sustained investment. Targeted government interventions to ensure price stability for steel producers will therefore be vital for the transition to green steel.

21. What interventions and examples of international best practice to support businesses on energy, would you recommend in order to increase investment and growth, including those across the steel supply chain? For example, is there a certain electricity price level by a certain date that would incentivise investment?

22. Which countries are your key competitors in and what electricity prices do you expect to see there in the future?

23. What are the biggest opportunities for decarbonisation in steel?

Based on the UK's current capabilities, the primary avenue for the decarbonisation of steel is investment in EAF technologies. Some important areas for development in this sector include maximising the scrap content at input, maximising the value delivered by exploiting both the steel and the byproducts produced in the highest value applications available, running EAFs fully on clean energy and reducing the energy intensity of operations.

Electrification of heating further presents an opportunity for decarbonisation in steel by replacing gas furnaces with clean energy sources. Up to half of EAF-based steel producer emissions arise from heating via natural gas in the rolling and reheating of steel. Electrification offers potential to significantly reduce emissions as well as providing greater energy efficiency.

Transportation impacts should also be considered, for example long distance transportation or the export of scrap overseas and import of products can impact carbon emissions.

Hydrogen and CCUS may also present opportunities for the decarbonisation of steel in the coming years, however there are significant challenges and uncertainty in this regard. There is currently virtually no emissions-free hydrogen production world-wide and none in the UK. Producing clean hydrogen power for steel manufacturing will either require a large surplus of CCUS capacity, the potential for which is uncertain, or a large surplus of emissions free electricity, which is unlikely given competing demands associated with the electrification of transport and heating. Further evidence is therefore needed to understand the role hydrogen and CCUS may play in the future of green steel. In any event, careful, long-term planning from government will be essential if these technologies are to be deployed responsibly.

From a global perspective, the government of China has stated that it expects to reach peak carbon output by 2030 and neutrality by 2060. To support this transition, in 2023 the government proposed that 15% of the country's total steel output should be derived via EAF routes by 2025 and reach over 20% by 2030. The latest update in 2024, only 10.5% had been achieved partly due to insufficient steel scrap availability and recycling infrastructure as well as the economic risk for many steelmakers in having stranded assets. In comparison, the government of India has set a goal to be carbon neutral by 2070. However, the Indian steel industry is aiming to achieve neutrality by 2047, with TATA Steel setting a goal to be net-neutral in carbon emissions by 2045.

With the industry dominated by large players, there is optimism that this 2047 target is achievable.

24. How important is buying 'green' or low CO2 steel to you or your customers right now? How important will it be in the future?

The demand for green steel varies significantly between clients and sectors. The extent to which producers are invested in green credentials is often driven by the demands of end users. The primary sector pushing for greener steel is automotives, with a major focus on accessing higher strength formable steel grades. Other sectors, such as fossil fuels and offshore wind where there are significant volumes of steel required and steel is the primary material used, there is a greater emphasis on cost and thus there tends to be a lower willingness to pay a green premium. Ultimately, these costs must either directly cut into profit margins or be passed onto consumers, impacting competitiveness.

As such, there is a significant role for government to play in supporting the cost competitiveness of green steel manufacturing and supporting its demand. This includes introducing programmes to ensure affordable and stable clean energy prices for steel producers, supporting research, development and innovation that contributes to cost efficiency in green steel processes, investing in infrastructure to enable greater circularity in steel supply chains, and introducing fiscal mechanisms to incentivise the production and purchase of low carbon steel.

For relevant products, the consumer can play an important role in driving the demand for greener or low emissions steel. Transparency and effective communication including clear labelling are key to empowering the consumer to make more sustainable choices.

25. Are there any measures government should explore, beyond the planned and existing ones outlined above, to reduce the risks of carbon leakage for the UK steel industry?

The UK government must ensure that the implementation of the CBAM is as closely aligned with the EU's timeline as possible. Any delay will make the UK the primary target for exports and risk overwhelming domestic supply chains. The global steel market is dominated by overseas producers with lower operation costs, typically higher emissions and cheaper outputs than UK industry.

Low cost, high-carbon steel imports undermine both the UK's environmental ambitions and the domestic steel industry. For context, Tata Steel is the only producer of hot rolled strip in the UK and while it is currently building an EAF, this will not be producing liquid steel until 2027 at the earliest. In the interim, the UK strip business risks being overrun by low-cost imports. The government must take action both to support the rapid transition to low carbon steel and to ensure the full and effective timely implementation of the CBAM.

26. How can UK government encourage innovation in the steel sector, enhance collaboration and increase investment in RDI?

The UK has significant potential to develop as a hub for steel innovation. This will only be realised with genuine and effective connections between the practical needs of end users and academic researchers. The government has an important role to play in fostering enhanced collaboration

between sectors and between industry and academia. Targeted, challenge led research funding that is geared towards collaborations between industry and academic partners is key. Current and past initiatives connecting academics and industry should be built upon and the growing connectivity through catapult centres accelerated. Learnings and best practice from other sectors that are effective at collaboration and investment should be applied. Overcoming remaining siloes and running integrated projects that encourage collaboration across sectors will be crucial to building better value propositions for end users rather than just optimising within a sector. For example, this could include more targeted Catapult type activities similar to APC or ATI. This will be key to boosting innovation and achieving the technological advancements needed to grow the industry.

Given the pressing need for further research and innovation associated with EAFs and downstream processing of high scrap content steels to high quality products, a proactive government approach is needed in this area. Consideration should be given to developing the UK as a focal point for innovation for non-UK steel makers that have limited R&D capacity. It is essential that the current UK strength of academic excellence in steel, which is distributed in several universities with associated state of the art facilities is harnessed and built upon. A way to unite this expertise together to maximise the UK's relevance in the global landscape and answer moves by China to centralise research and talent would be beneficial. Strategic oversight could also help to check compatibility of parallel innovations. Key areas of focus could include process metallurgy, modelling and AI, product development, energy solutions and materials recovery.

Attracting inward investment into the UK from emerging / existing innovative businesses with disruptive technologies should also be considered. This presents an opportunity to invest in businesses that are already developed beyond lab-scale demonstrators that are actively seeking and attracting series B (and beyond) level of funding.

27. Which areas and types of innovation are most likely to produce a successful and competitive UK steel sector? Could such impacts be achieved in both the short or long term?

Innovation to position the UK at the forefront of the green transition in steel will be vital to ensuring a thriving and competitive sector in the years to come. This means embracing the shift towards a low-carbon, circular and resource-efficient industry and investing heavily in research that supports this. Alongside focus on primary steelmaking, substantial value is added down-stream, particularly in finishing and coating mills offering further opportunities to produce a successful and competitive sector.

Key areas likely to produce a successful and competitive UK steel sector include:

Security of supply:

- Innovations that improve the security of supply and reduce price volatility of both raw material and energy supplies could improve the commercial sustainability of the UK steel sector.

Low carbon steel production:

- EAF development such as optimisation for different steel grades not currently made by EAF and overcoming current technical challenges.
- Overcoming downstream processing challenges for control and optimisation for new high scrap content chemistries.
- Clean energy integration.
- Waste heat reuse and energy storage solutions.

Circular economy and co-production models:

- Valorisation of steel manufacturing waste streams and the effective use of beneficial residual elements. For example, to manufacture alloy, stainless and tool steels or steel-cement co-production, involving the re-engineering of steel slag for low-carbon cement production.
- Advanced material recovery, including enhancing scrap sorting and refining to increase recycled steel quality.
- Furthering industrial symbiosis building on outcomes of the transforming the foundation industries challenge and connecting steelmakers with other industries such as cement, chemicals and energy, to utilise waste streams efficiently.

Resource efficiency:

- Innovations in processing and processing control such as new tooling, other new process routes, use of digitalisation/AI for process optimisation and control that can be scaled rapidly within existing technology infrastructures while delivering substantial resource savings.
- Innovations in finishing and coating mills could act as differentiators in the market and support UK priorities.
- Software to support optimal design decisions, for example in the design of steel-framed structures, and avoid repeated patterns of over-specification.
- Process simulation to accelerate other innovations.

Retaining knowledge within the UK and making the most of existing infrastructure will be crucial particularly to realise longer-term impacts.

28. What skills does the industry need today and how are they likely to change over the next 10 years?

Delivering the government's ambitions for steel will only be possible with a pipeline of skilled workers to deliver growth and innovation. Metallurgists and technicians who have the relevant knowledge, qualifications, experience, skills and training are required to realise the opportunities available in UK steel. Ferrous metallurgy skills are vital and in short supply, including both product and process knowledge. Metallurgy is facing an ageing workforce and there are limited training and education programmes to bring in new talent. In material sciences and engineering,

metallurgy usually forms just a small part of a degree programme and opportunities for part-time students to pursue a qualification in this field are highly limited. Degree apprenticeships offer an opportunity to develop talented individuals and close this skills gap. In addition, an industry led doctorate programme could help to provide the specialist skills required and help to facilitate knowledge exchange with the retiring workforce.

In addition to metallurgy, skills in modelling, simulation, machine learning, digital twinning, AI and large language model engineering skills are becoming increasingly important and are in substantial demand across a range of sectors. It is not clear that the UK has sufficient capacity in these areas to support the steel industry. An essential aspect of developing this skills base will be ethical and responsible use of AI as well as awareness of the data, hardware and electricity and water cooling requirements and associated cost and sustainability impacts. Moreover, as the scale of data-driven work in steel expands, data scientists are also becoming a key workforce for the industry.

There is growth in demand for skills related to sustainability and circularity, particularly associated with switch to EAF-based steelmaking and increased utilisation of scrap. A key skill that is lacking and necessary is through chain/process/end-to-end specialist knowledge.

Finally, access to skills will be a major factor in the delivery of essential research to enhance competitiveness and effectively transition the steel sector. Materials scientists will be needed to develop alloys and run trials at scale. Moreover, specific skillsets associated with EAF steelmaking and innovation are required which could be achieved through knowledge transfer from existing plants or a dedicated training scheme. In addition, an increase in electrical engineers will be required as the industry moves towards electrification.

29. What are the biggest barriers to attracting and retaining talent in the steel sector?

There are major barriers associated with meeting the workforce needs of the steel sector. As noted above, metallurgy has an ageing workforce and attracting new entrants to the field is a challenge. Steel is not recognised as a high-tech field by the public and is generally not seen as a desirable career path by younger generations. Public perceptions that the industry is old and dirty are outdated. In addition, incentivising workers to relocate for employment in steel can be challenging. Finally, decades of underinvestment in the industry, and the relatively small market of steel employers located in the UK, have impacted the extent to which this sector is considered a reliable source of work.

A vital aspect to attracting new talent is promoting the role of steel in the green transition. Younger generations are often invested in sustainability and want to see a social and environmental impact from their work. As such, it is necessary to convey a clear image of what the future of steel looks like and the opportunities available to contribute to cutting edge green technologies in this sector.

30. What support could UK government provide, or work with devolved governments to provide, the steel sector to best develop our skilled workforce? Is the steel industry able to train in the UK or should the skills needed be imported?

There is a substantial role for the government to play in developing the necessary talent base for the success of steel. In particular, targeted support for the metallurgy sector is needed. Metallurgy is not taught as a standalone topic for first degree at any UK university. Only three (Cambridge, Manchester and Sheffield) currently have undergraduate courses that explicitly mention metallurgy in their titles (a fourth at Birmingham has now closed to new entrants). Generally, metallurgy is taught as part of wider materials science and engineering courses, which is offered at nine UK universities. At pre-university level metallurgy training from operator to technical and then investigator or supervisor levels exist, but these tend to be short (mainly one day). Currently, there are few providers of an Ofqual certification in metallurgy for part time students. CPD courses for people already working in the field are typically for one very specific aspect of a very broad field. There are a few apprenticeships at Level 3 or 4 where apprentices require very limited knowledge of ferrous and non-ferrous metals – this might be one or two statements out of 20-30 Knowledge Skills and Behaviours.

Opportunities include harnessing the role of degree apprenticeships and an industry-led doctorate programme (CDT like) to help provide the specialist skills required and help facilitate knowledge exchange with the retiring workforce.

In addition to building, transferring and upskilling domestic talent, the opportunity to attract skilled workers from overseas should be pursued.

Without active support and promotion from government, current trends risk leading to severe skills shortages and making the ambitions of the steel strategy unworkable.

As noted above, there is also a need to attract a wider range of talent and skills to the steel sector, including digital skills, electrical and material engineers and data scientists. There is a role for raising awareness of careers in steel, including to schoolchildren, university students and professionals at all stages. A positive and effective transition to green steel will support a strengthened industry and help to improve its image organically to a more positive one. Again, showcasing the future of green steel and the potential to advance environmental sustainability through this sector will be vital.