UK STEEL
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# NET ZERO STEEL
## A VISION FOR THE FUTURE OF UK STEEL PRODUCTION

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July 2022

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# 1. EXECUTIVE SUMMARY

## The Grand Challenge

Steel enables everything from our buildings, transport, utilities, communication systems to our consumer products. Crucially, steel is essential to our zero-carbon ambitions: wind turbines, electric vehicles, low-carbon homes and nuclear powerplants will all be built with and of steel. Today the world consumes 1.9 billion tonnes of steel a year, 250 kg for every person, and this continues to grow.

But our consumption of steel comes with an environmental impact. Globally each tonne of steel produced gives rise to an average 1.85 tonnes of $CO_2$ ($tCO_2$), accounting for around 7-9% of global emissions. The UK's consumption of steel alone results in over 29 million $tCO_2$ emitted each year. If the world is to have any hope of halting climate change, we must find ways of producing steel without the emissions. This represents the most significant transformation of the sector since the industrial revolution with numerous technical, economic and policy challenges to overcome very quickly.

The UK has consistently been at the vanguard of climate action, a first mover and figurehead for action and we are once again well placed to show leadership, forming a long-term industry and government partnership to deliver the world's first Net Zero steel sector.

## A Net Zero UK steel sector

The UK produces 7 million tonnes of steel each year, giving rise to around 11.6 million $tCO_2$. The bulk of emissions (approximately 96%) come from the UK's two blast furnace sites, situated in Scunthorpe and Port Talbot, responsible for around 6 million tonnes of steel production each year. The remainder of emissions, and steel production, come from four electric arc furnaces situated in the Sheffield region and Cardiff as well as from many other downstream manufacturing facilities situated across the UK. However, the emissions related to the steel we import and consume in the UK are far greater. The imported steel used in sectors such as manufacturing and construction and significant volumes of imported goods containing steel, give rise to 18 million $tCO_2$, meaning the UK is ultimately consuming around 16 million tonnes (Mt) of steel each year and responsible for 29 million $tCO_2$.

In establishing a vision and strategy for decarbonising steel, the UK must concern itself not merely with the emissions from domestic production but take a wider view and aim to reduce the overall emissions related to our steel consumption here in the UK. Only by taking a global view, accounting for consumption and production, can the UK avoid decarbonising through deindustrialisation and losing the industrial capability, jobs, resilience, and other benefits that come from a domestic steel sector. Creating a mass market for Net Zero steel in the UK will drive down our consumption emissions and establish the conditions for UK steel companies to invest in decarbonisation, confident that they can gain a return on that investment.

**There are two key targets for the steel sector:**

- **The Government's 2050 Net Zero target, which could require the steel sector to reduce its emissions by over 95%.**
- **The Climate Change Committee's 6th Carbon Budget for 2033-37 includes a recommendation for all ore-based steelmaking to be near zero emission by 2035.**

This report will seek to demonstrate how such targets can be met should the right policies and investment support be put in place to address the barriers to steel sector decarbonisation.

## Barriers to Decarbonisation

Meeting these targets will entail tackling several technical, economic, and policy challenges. This will require significant investment and commitment from the industry, but equally new policy development and significant intervention from the Government.

### Electricity Prices

Net Zero steel production will be significantly more electricity intensive than traditional methods of production. All the major technologies required – greater use of electric arc furnaces, blast furnaces fitted with carbon capture, utilisation, and storage (CCUS) technology, Hydrogen steel production – will vastly increase a steel company's demand for electricity. For example, electric arc furnaces require three times more grid electricity to produce the same volume of steel as a blast furnace.

However, power prices for UK steel producers are almost 60% higher than those available to their direct European competitors. Parity of electricity prices is essential to attracting investment from multinational companies and addressing this imbalance must be the first step on the road to decarbonisation.

**Technical Challenges**
Decarbonising the steel sector will require the development and application of new technologies not yet implemented anywhere in the world at scale. Whilst the precise mix of technologies has not yet been determined, it could include:

- A move, potentially in part, to more electric arc furnace (EAF) steel production capacity in the UK
- The application of CCUS technologies to a range of steel production processes
- The replacement of natural gas in downstream processes with alternative 'green' fuels
- Advanced sorting technologies to improve the quality of steel scrap supply
- Improvements in electric arc furnace technologies to increase the production range available
- The introduction of alternative ore-based steel production processes, including HIsarna and Direct Reduced Iron (DRI) technologies like MIDREX and HYL, likely available after 2035.

**Business Case and Trade Challenges**
Producing steel with Net Zero emissions is significantly more expensive than traditional alternatives. The cost of emitting carbon has not yet been internalised within the cost of steel and prevents companies from investing in decarbonisation because there is no method of receiving a return on the additional CAPEX and OPEX (capital and operating expenditure) required.

The UK imports 60% of its steel requirements and exports 45% of its production. Steel is one of the most highly traded products in the world, and therefore in the absence of other interventions, significant national imbalances in production costs will quickly render producers uncompetitive in both domestic and export markets.

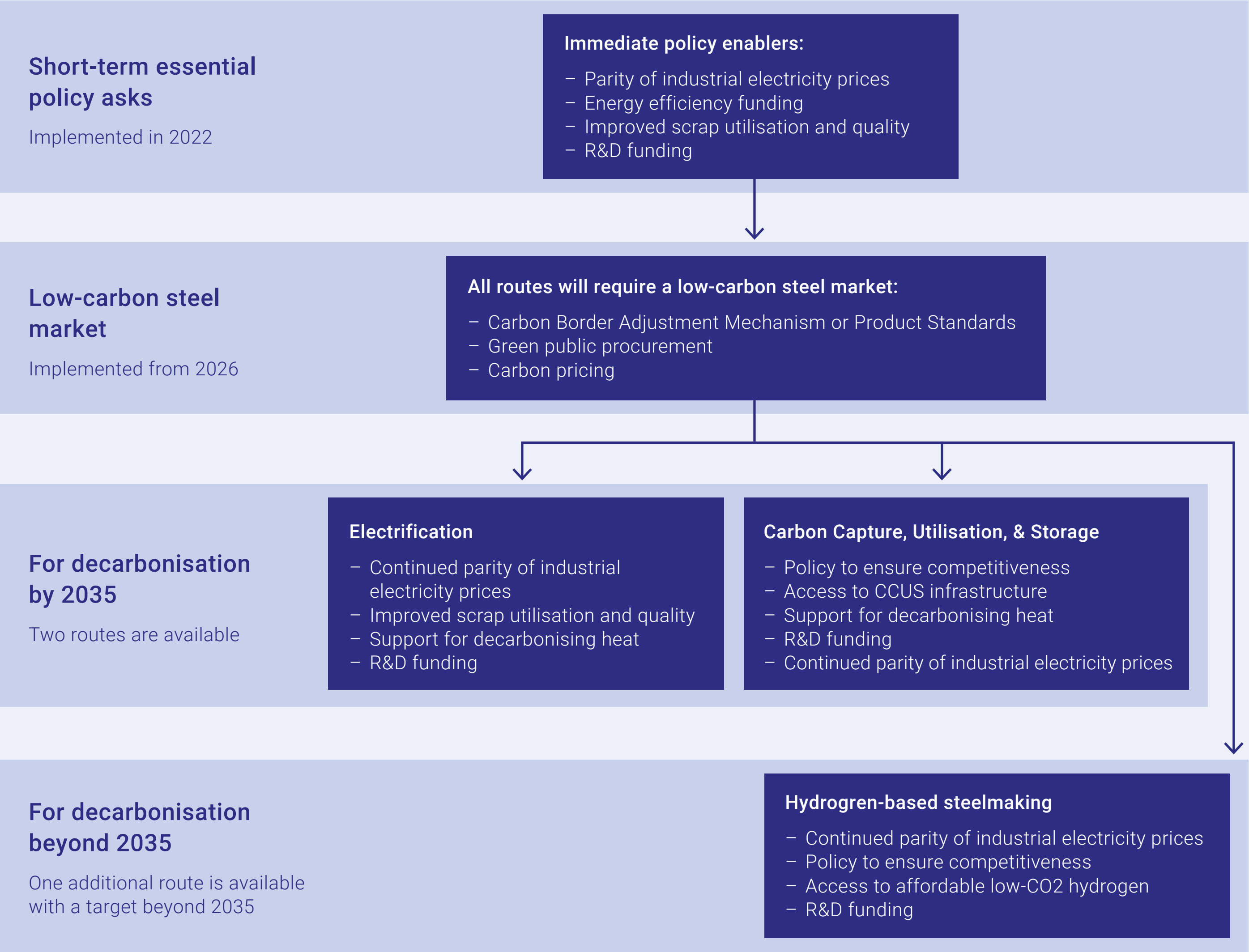
Without a global carbon price, where all steel producers worldwide face the same cost of emitting carbon, increased climate change ambitions and accompanying costs in the UK will lead to offshoring of production and investment. This leaves the UK Government with two key policy approaches:

- Creating a Net Zero steel market: This approach is similar to the automotive market, where the Government has intervened to ban the sale of new internal combustion vehicles from 2030. Policy recommendations include Carbon Border Adjustment Mechanism, Product Standards, and Green public procurement.
- Direct support for Net Zero steel production: This mirrors the approach taken for the power sector, where renewable energy generators are provided with a guaranteed price via a levy on energy consumers. Examples of this include co-investment in significant asset and infrastructure changes before the end of their natural lifespan, R&D funding, and support for hydrogen production and infrastructure.

There are significant growth opportunities, with the forecasted UK demand for finished steel expected to grow from 9.4Mt in 2015 to 11.0Mt in 2030[1]. This growing demand and the ambition to increase our share of the domestic market, represents a 6.8Mt/£3.8bn a year opportunity for the UK industry. Meeting Net Zero targets will be transformative and an opportunity for significant growth as the UK sector establishes itself as leading supplier of Net Zero steel products and technologies both here and overseas.

## Policy Solutions

Crucially, the business environment for UK steel producers must be enhanced to improve competitiveness, and enable investment, transformation, and growth. Any route to decarbonisation will require the establishment of a Net Zero steel market, enabling new costs, not faced by carbon intensive steel producers, to be recovered through the sale of our products. There are two main technology routes available with a decarbonisation target of 2035: electrification and CCUS. Both can be implemented by 2035 and if the right policy framework and investment support are in place, even sooner. For the sector to further decarbonise beyond 2035, technologies such as hydrogen-based steelmaking would need to become a feasible option. Accompanying each of these technology routes is a summary of the policy interventions that will be required.



**Short-term essential policy asks**

Implemented in 2022

**Immediate policy enablers:**

- Parity of industrial electricity prices
- Energy efficiency funding
- Improved scrap utilisation and quality
- R&D funding

**Low-carbon steel market**

Implemented from 2026

**All routes will require a low-carbon steel market:**

- Carbon Border Adjustment Mechanism or Product Standards
- Green public procurement
- Carbon pricing

**For decarbonisation by 2035**

Two routes are available

**Electrification**

- Continued parity of industrial electricity prices
- Improved scrap utilisation and quality
- Support for decarbonising heat
- R&D funding

**Carbon Capture, Utilisation, & Storage**

- Policy to ensure competitiveness
- Access to CCUS infrastructure
- Support for decarbonising heat
- R&D funding
- Continued parity of industrial electricity prices

**For decarbonisation beyond 2035**

One additional route is available with a target beyond 2035

**Hydrogren-based steelmaking**

- Continued parity of industrial electricity prices
- Policy to ensure competitiveness
- Access to affordable low-CO2 hydrogen
- R&D funding

# 2. CLIMATE CHANGE TARGETS

## 2.1. Existing targets

In 2019, the UK Government established a Net Zero climate change target with the aim of reducing the UK's territorial emissions to as close to zero as possible and removing from the atmosphere any residual emissions that cannot be eliminated. In its advice, the Government's official advisor, the Climate Change Committee (CCC), suggested that this would lead to over 96% emission reduction for the steel sector by 2050, profoundly impacting how steel would be produced in the UK.

After adopting the 2050 Net Zero target, the CCC subsequently published its advice on the Sixth Carbon Budget, which provides ministers with advice on the volume of GHG the UK can emit during the period 2033-2037. Its analysis suggested that the most cost-effective route for industrial decarbonisation would entail ore-based steelmaking being near-zero emissions by 2035, requiring a rapid acceleration of the transition to Net Zero steel production*.

This report outlines how such targets could be met through a partnership between the UK Government and the steel industry.

## 2.2. Context

The UK has consistently been a first-mover on climate action, showing global leadership through our ambitious targets and firm action. The UK was the first to set legally binding emissions reductions targets, the first major economy to adopt a Net Zero target, has decarbonised electricity generation faster than any other country, has the world's largest offshore wind generating fleet, and will be the first in the G7 to ban the sale of internal combustion vehicles.

To date, no country has set targets for industrial emissions. But, with a tightening of national targets and impressive progress achieved on power and transport-related emissions, attention will now also turn to the 'harder to treat' sectors like steel. Steel production and consumption will be an unavoidable component of any modern low-carbon society. But with it accounting for 8% of global emissions and 3-5% of the UK's emissions[2] and the long timeframes required for transition, the same sense of urgency and action that has been given to sectors like power and automotive will be needed if targets are to be met.

The UK's Industrial Decarbonisation Strategy, published last year, was an important step in this process, setting out indicative targets of 66% and 90% reductions by 2035 and 2050, respectively, along with a high-level delivery plan on how these will be achieved. But after hosting COP26, the UK could once again be at the forefront of climate action and be the first country in the world to establish explicit targets and policies to deliver both a Net Zero steel sector and, crucially, a Net Zero steel market. In doing so, the UK steel sector could be a world leader in clean steel production. But it is critical that we move quickly. Multiple countries in the EU and further afield are developing and implementing steel decarbonisation plans today, and the UK must not be left behind.

## 2.3. Delivering on targets

Delivering on any targets will require a partnership between industry and government, providing the right policy environment in which to unlock the significant private sector investment needed. Individual company decarbonisation pathways remain commercially sensitive at the current time and are the subject of direct conversations with the Government, but the following can be established here:

- An 80% reduction of emission intensity by 2035 could be achieved by:

    - A combination of electrification, CCUS and DRI technologies to reduce emissions from ore-based production
    - Grid decarbonisation will continue to drive down indirect emissions, particularly those related to EAF production.
    - Ongoing investments in energy efficiency and carbon reduction projects to continue to provide incremental reductions in energy consumption and carbon emissions.

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*For the purposes of this report, the term net zero steel is intended to mean steel products, the production of which involves such low emissions as to be consistent with the 2050 net zero planning assumptions of the UK's statutory Committee on Climate Change. A wide range of emissions reporting scopes exist but there is, as yet, no harmonised and globally recognised definition of net zero steel nor green steel. A number of organisations, including but not limited to World Economic Forum, Energy Transitions Commission, ResponsibleSteel™, Science-based Target Initiative and the ACT Initiative are currently working on the development of such a definition. The UK steel sector commits to working with the UK Government to establish a precise meaning for net zero steel, building on these international developments as appropriate to the UK context.

- Net Zero emissions from UK steel production by 2050 could be achieved by:
    - Decarbonisation of downstream processes (rolling, drawing, forming processes), principally through the replacement of natural gas with hydrogen, 'green gas', and, where possible, electricity.
    - Where EAF/DRI technology has been used, further emissions reductions will be made by capturing carbon from DRI plants or using hydrogen.
    - Where carbon capture has been fitted to blast furnaces (BF), increased capture rates will be achieved, and the use of biomass will be explored.

## 2.4. Government partnership

Unlocking the necessary investment from industry will take a firm commitment from the Government to implement the right policies and, where necessary and appropriate, the proper capital funding support. Additionally, the Government must make a high-level commitment to creating a viable market for Net Zero steel in the UK. A robust domestic market where UK steel companies can secure returns on their decarbonisation investments must be the foundation that will underpin any Net Zero strategy for the sector.

The specific policies that will enable this are detailed in section 8 and will need considerable further development, but in establishing a vision for Net Zero steel, the Government should make a public commitment to increasing the market advantage for net-zero steel through to 2050, with a requirement for all steel consumed in the UK after this date must be produced using Net Zero production methods.

# 3. INTRODUCTION – A CLEAN STEEL SECTOR BY 2035

The invention of the Bessemer process in Sheffield in 1857 led to steel production in quantities and at a cost never before conceived of, and it triggered with coal, steam, and ultimately electricity to the most comprehensive and rapid transformation of society the world has ever seen. Today, the steel industry adage that "*everything is made from steel or made using steel*" still applies, and we are as much in an age of steel as we ever were.

Climate change poses a new industrial challenge with the need to reduce the level of carbon emissions radically and rapidly. However, the transition away from fossil fuels will not be accompanied by a similar shift away from steel. Uniquely, steel is highly cost-effective, adaptable to a vast array of different applications, and infinitely recyclable. An alternative material for the vast majority of the 1.9 billion tonnes of steel used each year globally will not be found. Steel will be an enabler of the low-carbon industrial revolution, as it will be required for wind turbines, electric vehicles, rail networks, low-carbon buildings, the transformation of our energy networks and much more besides.

Steelmaking is a carbon-intensive process, giving rise to 7-9% of all global greenhouse gas emissions, and with the world's consumption of steel continuing to grow at over 3% each year[3], there is an urgent need to address those emissions. The challenge of decarbonisation requires the most fundamental transformation of the steel sector in modern history.

No steel company in the world has managed to decarbonise its production process yet, and the UK, a prosperous developed economy with a relatively small and condensed steel sector, is better placed than most to tackle the challenge. Crucially, cutting emissions from the steel sector in the UK must be seen not simply in terms of the steel produced here but also the steel consumed here. Prior to the Industrial Decarbonisation Strategy, climate change policy to date has concentrated almost exclusively on territorial emissions, those produced within our borders, without any real consideration of the emissions that arise from the products we import and consume. There is a risk of bringing about industrial decarbonisation through deindustrialisation, an increased reliance on imports, and offshoring of emissions and economic value. The UK would severely diminish its ability to reduce industrial emissions and is likely to increase global emissions as it becomes increasingly reliant on imports from countries where decarbonisation is less of a priority. Instead, the steel industry and UK Government must come together to develop a policy framework, building on that outlined in the Industrial Decarbonisation Strategy, for the establishment of Net Zero steelmaking.

Placing the myriad technical challenges to one side, the biggest challenge we face is in establishing the business case for investments in Net Zero steel production. Today most of these investments would increase a steel company's capital and operational costs and make it less competitive. New policies are needed to encourage the sector to make investments while maintaining, or even gaining, market share. The UK has an opportunity to provide global leadership on advancing industrial decarbonisation by pursuing this approach.

In publishing this report, the UK steel sector is clear in its ambition to transition to Net Zero steel production, ensuring the Government can meet its historic net-zero carbon targets. We could establish the UK as the first major economy to have completely decarbonised its steel production, following in the tradition of being the first major economy to commit to a Net Zero-emission target. In doing so, we could set an example to the global steel sector and even establish the UK as a net exporter of low-carbon steel to help other countries reduce their consumption-based emissions. With the right support and a committed and strong partnership between industry and government, the UK steel sector could decarbonise by 2035.

# 4. STEEL’S IMPORTANCE IN A LOW-CARBON WORLD

Steel is present throughout modern society, from energy, to transport, buildings, manufacturing, and communications. From global production of 189Mt in 1950 to 1.9 billion tonnes last year, the growth and development of the global economy are still intrinsically linked to steel production and consumption.

Through 160 years of modern steel production, we have an incredibly diverse material that contributes significantly to delivering a lower-impact society. Unlike plastics and many more recently developed materials, it is potentially endlessly and easily recyclable, never being downcycled. Moreover, it is already economical, and we have the infrastructure in place to do this. Steel is also infinitely versatile – there is no other material that can be used for everything from car bodies to bearing the weight of our buildings, to transporting our energy, as the foundation of our rail networks, the packaging for our food, and in electric motors. There are currently around 3,500 different types of steel in existence, with more constantly being developed. Moreover, it is also incredibly cost-effective, estimated at 75% the cost of aluminium and 18% of the cost of carbon fibre[4]. There is also an excellent opportunity to transform carbon-intensive jobs into green jobs, which are located principally in Yorkshire & Humberside, Wales, the North East, and the Midlands. The average wage of steel employees is 18% higher than the UK average and 36% higher than the regional average in Wales and Yorkshire & Humberside, supporting a green and just transition.

## 4.1. Net Zero society

Steel is especially fundamental to a future Net Zero society. As the UK transitions from a high-emission economy to a net-zero emission economy, new infrastructure will be needed. The energy system will transition from centralised, large combustion plants to decentralised small power generation such as wind, solar, bioenergy, and small modular reactors (SMRs). This will require more steel as we build more wind farms, expand solar energy, and construct nuclear SMRs. New electric vehicles are needed, and the public transportation network needs to be expanded[5]. New energy-efficient homes will be built, and the existing housing stock will need to be retrofitted with increased insulation and new heating systems.

## Sustainable housing

Credit: WorldSteel

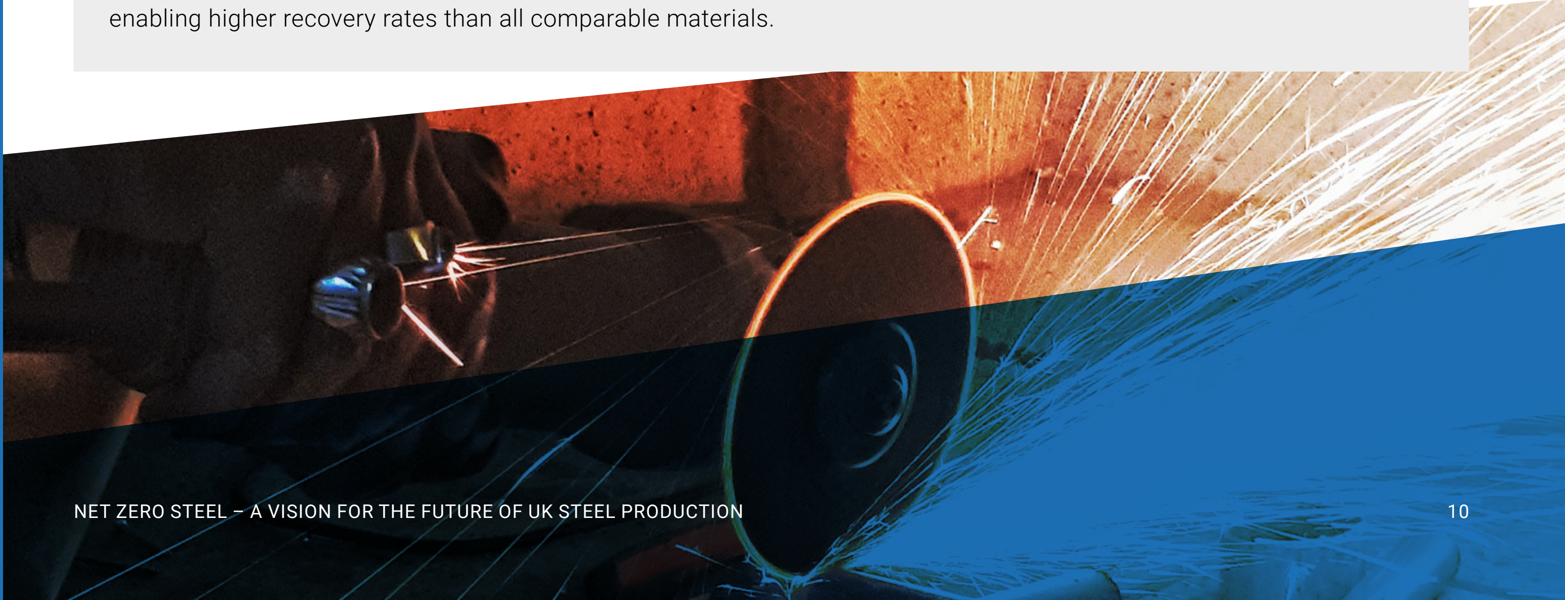
It is well understood that the houses we live in make a substantial contribution to greenhouse gas emissions, both in terms of the resources required to build them and the energy consumed within them. As with so much else in our economy steel plays an important role, both as of a major contributor to construction related emissions, but also increasingly as a way of reducing the whole life-cycle emissions of our homes.

The Government's Net Zero strategy sets out important objectives in respect of these challenges, including: a new rigorous "Future Homes Standard" to be introduced from 2025 requiring all new dwellings to be 'ready for net-zero', requirements for all existing houses to reach EPC band C by 2035, and plans to introduce maximum embedded carbon levels for new buildings and infrastructure in the future.

More than half of all steel produced worldwide goes into buildings and infrastructure – decarbonisation of steel production will therefore play a huge role in reducing embedded emissions in buildings. Equally, new methods of construction, such as modular and off-site construction, will mean steel plays an increasingly prominent role in improving resource efficiency in the construction sector and reducing embedded emissions through building design. Such methods of construction, making significant use of the beneficial properties of steel, require less materials to produce a high-quality, energy efficient building, and smaller foundations are required. Steel is also lightweight compared to many other building materials used for the same purpose, which can result in dematerialisation. For example, 1kg of steel is sufficient to cover almost nine times the area of 1kg of roof tiles.

Steel can also assist in reducing energy use through solar thermal generation. Perforated steel panels can collect around 50% of the solar heat energy falling on their surface by heating a boundary layer of air on the outside surface of the steel. This warm air is drawn through perforations into a cavity and then onwards into the building.

Eventually, however, most buildings will be decommissioned. Reusing or recycling building components is key to the sustainability of a structure's end of life, as it is the most economical and ecological solution. When a steel-framed building is demolished, its components can be reused or remelted in the steel industry's closed-loop recycling system. Thanks to its magnetic properties, steel can easily be separated from waste streams, enabling higher recovery rates than all comparable materials.



## Wind Turbines

The UK Government has committed to expanding the UK's offshore wind energy capacity from 10GW today to 50GW by 2030. This will significantly increase the number of offshore wind farms and require powerful wind turbines. Every part of a wind turbine depends on steel. The blades are often made of carbon fibre but held in place by steel. About 90% of all wind turbine towers are tubular steel towers. The nacelle (top of the tower and contains gearbox, generator, and brakes) encompasses some of the highest-value steels, such as electrical steels, which are specifically tailored to producing the magnetic properties that make wind energy possible. The turbine generator is made of 65% steel and 35% copper. The foundations of the offshore wind turbines are almost entirely made of steel, and new floating turbines use steel floaters filled with a ballast of water and rocks. Gravity base foundations are the most used onshore foundations. Most gravity base foundations are made of steel-reinforced concrete slabs. Finally, steel is vital to the installation of the turbines, as it is embedded in ports, lifting equipment, trucks, trailers, and rail cars, and will be necessary for the network that transports the electricity to land via the transmission and distribution lines.

*Credit: WorldSteel*

## Steel in Transport

Mobility is essential to our modern way of life. The efficient transport of goods has become key to our ever more globalised economy. Freight, for example, has almost doubled over the past 30 years. Steel facilitates our mobility and the transport of goods. Whether in the form of cars, buses, trains, ships, or planes – or in the transport networks that support them – steel is essential to every mode of transport. Steel is well-suited to transport applications because it is durable, strong, lightweight, UV-resistant, affordable, and 100% recyclable. Rail transport requires steel in the trains and for the rails and infrastructure. For short or medium-haul journeys, rail reduces travel times and $CO_2$ emissions per passenger kilometre compared to nearly all other forms of transport[6]. The UK rail network, bolstered by HS2 will play a critical enabling infrastructure role in decarbonising the freight sector, as "*transporting freight by rail reduces carbon emissions by 76% compared to road haulage. HS2 will enable a shift from road freight to rail freight, decarbonising the UK transport sector and supporting the transition to net-zero carbon emissions by 2050*"[7].

## 4.2. Endless recycling

Unlike many other materials, steel is a permanent material that can be recovered with no loss of intrinsic properties and therefore is potentially endlessly recycled. This leads to steel being the most recycled material globally, as steel is never consumed but merely used. The recycling rate of steel depends on the end-use, but 82.5% of steel packaging is recycled[8], and over 99% of steel from scrapped cars is recycled. Similarly, a 2012 study showed that 96% of steel is recycled or reused when a building is demolished[9]. Furthermore, the infrastructure and incentive for recycling steel already exists, and the recycling process and infrastructure is efficient and economical, as it has existed for over 150 years.

## 4.3. Steel as a mitigation enabler

Steel can act as a critical enabler of climate change mitigation[10], where the emission savings are substantial compared to the emissions released by the steel-making processes. In eight case studies where there was almost no alternative to steel, a positive ratio of 6:1 between $CO_2$ savings and production emissions was found. The eight cases were: weight reduction of cars, efficient fossil-fuel power plants, offshore wind power, combined heat and power, other renewables, efficient transformers, efficient EV motors, and weight reduction of trucks. However, as the urgency and importance of reducing global emissions become ever more apparent, our use of steel is increasingly under the spotlight as a significant cause of greenhouse gas emissions.

# 5. STEELMAKING

## 5.1. How steel is made

Steel is today produced by one of two methods. Globally, 72% of steel is made via ore-based production in blast furnaces and basic oxygen furnaces (BOF) using coking coal and iron ore as its primary raw materials. A further 28% of steel is produced via scrap-based production in electric arc furnaces (EAF), melting and recycling scrap steel to make new steel products.

### 5.1.1. Ore-Based Steelmaking

With ore-based steelmaking in Blast and Basic Oxygen Furnace (BOF), the blast furnace is fed with coke, iron ore, and other minerals (in the form of sinter). Sinter plants turn iron ore particles into coarse-grained iron ore sinter at high temperature, fuelled by the coke particles ignited by gas burners, and the coke (almost pure carbon) is produced by heating coking coal. The gas produced via this process is subsequently used as a fuel onsite to generate electricity[11], as are gases from the blast and basic oxygen furnaces.

In the blast furnace, the carbon in the coke acts as a reductant to remove the oxygen from the iron ore, with carbon dioxide ($CO_2$) as the eventual by-product. At this stage, the resulting metal contains too much carbon to be of use in most applications. It is therefore transferred to a basic oxygen furnace where its carbon content is reduced by blasting oxygen through it – the resulting steel is further refined before being cast into slabs, blooms, or billets and put through rolling mills and other processes to produce 'finished' steel products. It is worth noting that the ore-based steelmaking can use scrap in its process, and some sites use up to 30% scrap steel, making the distinction between ore- and scrap-based production less clear.

**BOF Steelmaking:**
To produce 1,000kg of crude steel, the main inputs are roughly:

- 1,370kg iron ore,
- 780kg coal,
- 270kg limestone, and
- 125kg of scrap steel

*Source: WorldSteel*

**EAF Steelmaking**
To produce 1,000kg of crude steel, the main inputs are on average:

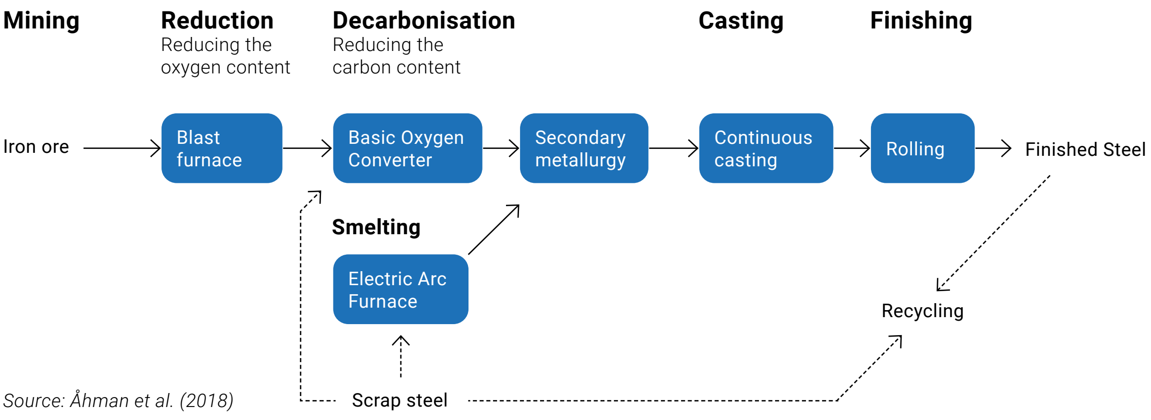
- 1,062kg scrap steel,
- 596kWh electricity
- 44kg lime, and
- 9kg coal/coke.

*Source: UK Steel*

### 5.1.2. Scrap-Based Steelmaking

Electric arc furnace (EAF) steelmaking uses steel scrap melted down and processed to produce new (recycled) steel. The EAF process can use 100% recovered ferrous scrap metal as the primary raw material, but can also include DRI, HBI or pig iron where needed. In this production, an EAF is used, applying a very high current through the scrap and melting it with $O_2$ injection or oxy-fuel burners fired by natural gas. The resulting steel is further refined before being cast into ingots, blooms, or billets and put through rolling mills and other processes to produce 'finished' steel products. The scrap-based process is more flexible and emits almost a sixth of the carbon emissions. Depending on the process and scrap steel used, contaminants, known as residual elements, from the scrap steel, such as copper and phosphorus, can remain in the finished product. The quality of the scrap and scrap segregation is therefore critical to the EAF steelmaking process.

**Figure 1 – Steel production**



*Source: Åhman et al. (2018)*

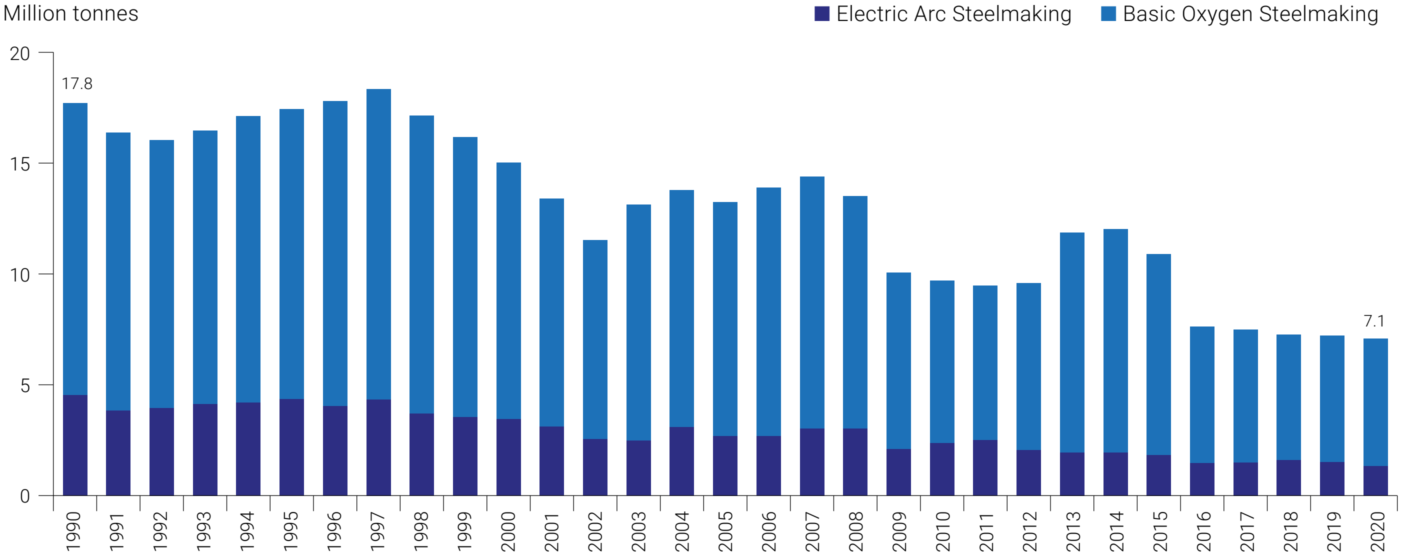
Steel is sold in over 3,500 different grades, from high-quality speciality steels to bulk steel – such as construction steel[12]. Steel products are divided into what are known as flat and long products. Typically, flat products are sold for automobile, domestic appliances, agricultural equipment, and machinery, and long products for construction, rail, aerospace, oil & gas, component manufacture, bar and rod, and infrastructure markets; however, there is a significant cross over between this. Long products are more readily produced via the scrap-based production route (EAF), where most product requirements have fewer demands on purity than those of many flat products. However, there are clear exceptions, where long products for aerospace, oil & gas, industrial engineering, rail, some wire and rod grades, forging automotive, and bight drawing all require high levels of cleanness, and well controlled residual levels can be achieved via the electric arc furnace route. It should be noted that many long products producers use blast furnaces as well as flat producers utilising the electric arc route.

## 5.2. UK steel production

In the UK, ore-based virgin steel is produced in blast furnaces at Port Talbot and Scunthorpe and accounts for around 80% of total steel production. Scrap-based production in Cardiff, Sheffield, and Rotherham account for the remaining 20%. Together, UK production was in 2021 7.2Mt of steel, compared to 17.84Mt in 1990.

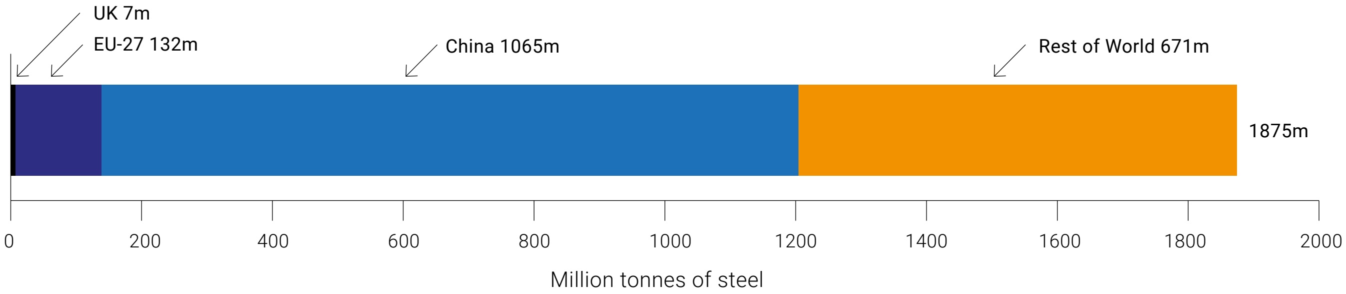
This production should be seen in the light of global crude steel production, which is illustrated in figure 3 and shows that UK steel production makes up 0.4% of global steel production. China is today the leading producer of steel globally at over 50%.

**Figure 2 – UK crude steel production**



*Source: International Steel Statistics Bureau*

**Figure 3 – Global steel production 2020**



*Source: International Steel Statistics Bureau*

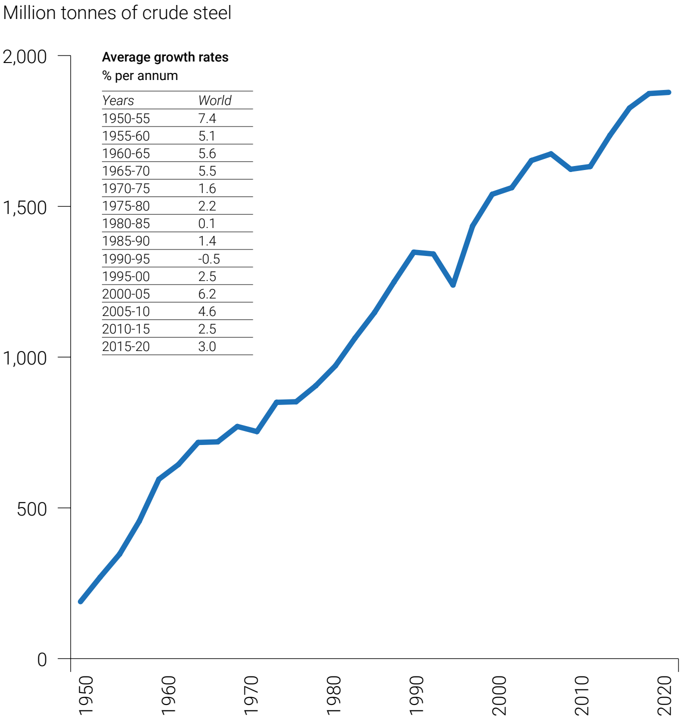
## 5.3. Steel requirements

Certain steel customers have strict requirements for impurity for particular steel grades (such as nitrogen content or other residual elements), which would presently be challenging to achieve via scrap-based production or at least uneconomical with existing scrap sorting technologies.

In the medium term, there will likely continue to be a need for ore-based steel production to meet the demand for specific steel grades in the UK and in the long term globally. Should the UK move to entirely scrap-based steel production, it would still need to import particular steel products in the medium term, and the emissions associated with this production would have been moved abroad without reducing overall global emissions. As there is a finite amount of steel scrap available worldwide, increasing scrap-based production in the UK would displace scrap-based production abroad and to an extent only reduce territorial, not global emission. That being said, scrap-based production in the UK is far less emission intensive than the global average. However, the need for additional virgin steel would still exist. Moreover, with around 10-11Mt of scrap steel produced in the UK each year, but with an overall consumption (including that imported in goods) over 16Mt, it is evident that we could not meet our steel needs through scrap recycling on volume terms.

Separately, there is a continuous increase in global demand for steel, with steel consumption increasing by 3.3% annually for the past 70 years - driven by population growth and industrial development. This equates to a doubling of world consumption every 20 years. Figure 4 illustrated this with the growth of steel production since 1950. The global population is expected to increase from 7.7bn today to 9.7bn in 2050, as developing countries urbanise and expand their infrastructure and building stock. Hence, global steel demand is expected to increase, highlighting the continued importance of ore-based production worldwide. As the world will still need ore-based production by 2050, the UK will face a choice; offshore high emission steel production or develop low-carbon, ore-based production methods. There could be a competitive advantage for developing low-carbon ore-based production in the UK, which could give rise to the export of industrial expertise, and the eventual demand for low-carbon steel products with fewer residual elements.

**Figure 4 – World Crude Steel Production (1950-2020)**

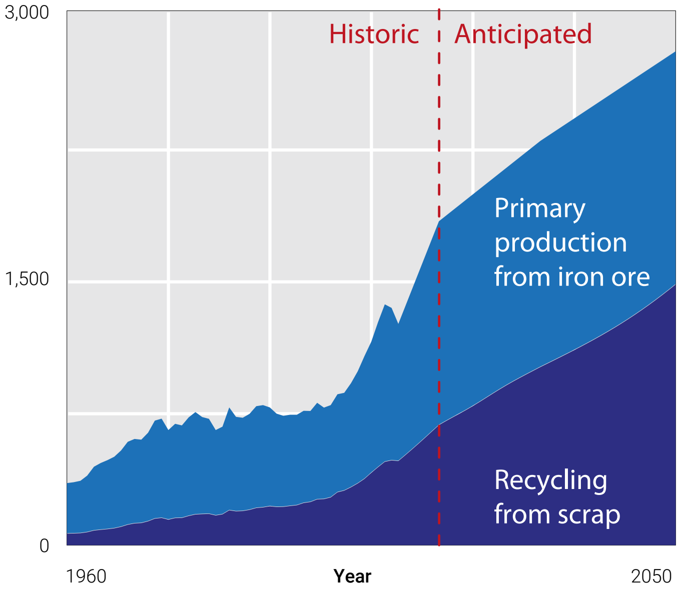


**Average growth rates**
% per annum

| *Years* | *World* |
|---|---|
| 1950-55 | 7.4 |
| 1955-60 | 5.1 |
| 1960-65 | 5.6 |
| 1965-70 | 5.5 |
| 1970-75 | 1.6 |
| 1975-80 | 2.2 |
| 1980-85 | 0.1 |
| 1985-90 | 1.4 |
| 1990-95 | -0.5 |
| 1995-00 | 2.5 |
| 2000-05 | 6.2 |
| 2005-10 | 4.6 |
| 2010-15 | 2.5 |
| 2015-20 | 3.0 |

*Source: World Steel Association, World Steel in Figures 2020*

**Figure 5 – Global steel output: Ore-based and scrap-based (Mt)**



*Source: Allwood, J., Dunant, C., Lupton, R., & Serrenho, A. (2019). Steel Arising: Opportunities for the UK in a transforming global steel industry.*

### 5.3.1. Product ranges

There are currently certain product ranges that are difficult to produce with higher scrap-content or require very high-grade scrap with low residual levels and/or a targeted chemical analysis. This limits how much primary ore-based production can be substituted by scrap-based production.

Steel is combined with other materials as a result of component and assembly manufacture. It is often difficult to fully segregate steel form other materials at the end of component and assembly life. Furthermore, iron is combined with both desirable and detrimental elements during the steelmaking process, some of these elements will not separate out during future steelmaking when the scrap steel is recycled. Non-desirable elements are known as residuals and result in a detrimental effect on the steel product. Depending on the grade of steel the residual may increase strength, reduce fracture toughness or generate non-metallic inclusions, the consequence being issues with formability and/or poor service performance. For flat products, which often require a high degree of formability, this strength is an issue. Long product rail also requires a high degree of internal cleanliness and much rail in Europe is therefore still made via the ore-based route.

There are examples of these challenges being overcome by steelmakers in other countries, through technology advances and by mixing different amounts of pig iron or DRI into the EAF melt to dilute the residuals from the scrap and increase product range. Improved technology on materials circularity will also be key to prevent valuable elements such as copper entering the EAF feedstock.

Nucor, SDI, and Big River Steel dominate US flat products production with over 20Mt of capacity. These plants use an average of over 30% ore based metallics (mainly blast furnace pig iron) in order to control residuals, as well as only purchasing high quality scrap (for example pre-consumer / production scrap from stamping presses, or highly sorted shredded end of life scrap). The role of pig iron in the EAF is also important for controlling nitrogen in the final product, where low nitrogen levels (<40ppm) are essential in highly formable flat products.

The Big River Steel plant is a relevant reference point for product capability through an EAF route, following investment in secondary steelmaking technology only previously seen in integrated steelworks to achieve ultra-low carbon grades. Their capabilities include producing products that cover the growing electrical steels market previously thought to be the exclusive provenance of the ore-based route, albeit using 80% ore-based metallics.

A new investment from SDI in Texas is due to come on stream this summer with a thicker cast slab compared to the other mini mills, so they can supply the local market for oil and gas pipe at heavy gauge. They have not invested in low carbon secondary steelmaking technology so while they may see improvements in surface, this is not targeting exposed auto or tinplate with this facility. Nucor is developing capability to produce ultra-high strength material as the demand for these new products grows from automotive with the switch to electric vehicles. The mini mill model is so far isolated to the US, with the notable exception of Arvedi in Italy. It should be noted that the high uptake of EAF steelmaking, with high metallic content where the BOS process will have dominated is in regions with low electricity and natural gas prices.

As such, this underlines the continued importance of ore-based production, which is necessary not only from a global perspective to meet increasing steel demand, but also from a product range perspective. Innovation will continue to expand what can be produced via electric arc furnaces, as evident above. However, for certain product range, ore-based metallics and production will be needed to compliment scrap-based production for the foreseeable future.

# 6. CARBON EMISSION OF STEEL PRODUCTION IN THE UK AND ABROAD

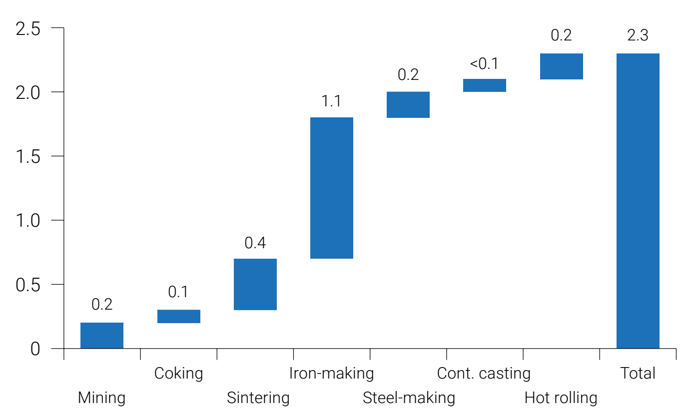
Steel production is a carbon- and energy-intensive process. Globally, for each tonne of steel produced, an average of 1.85 tonnes of $CO_2$ is emitted[13]. With the world's annual consumption of steel currently standing at 1.9 billion tonnes[14] and projected to increase each year, this amounts to over 3 billion tonnes of $CO_2$ each year, an estimated 7-9% of the global total[15]. There is a massive opportunity to reduce global emissions from decarbonising steel production significantly, but also a significant challenge in the enormity of the reduction required.

> Globally, the steel industry accounts for 7-9% of direct emissions from the use of fossil fuel. The majority of the $CO_2$ comes from the chemical reaction of steelmaking.
>
> *Source: WorldSteel*

Most emissions from ore-based steel production can be referred to as process emissions. Gases that contain the vast majority of the carbon are captured and used as 'works arising' gases lowering or removing the need to use natural gas or other gaseous fuels. These 'works arising' gases are used in onsite power generation (reducing the need to import electricity), fuelling the ironmaking process, and other uses such as fuel in re-heat furnaces. Liquid iron is processed into steel in the BOF converter where again gases can be collected containing carbon and re-used as a fuel alternative onsite. Process emissions also arise from the processing of steel, secondary metallurgy, casting, and hot rolling.

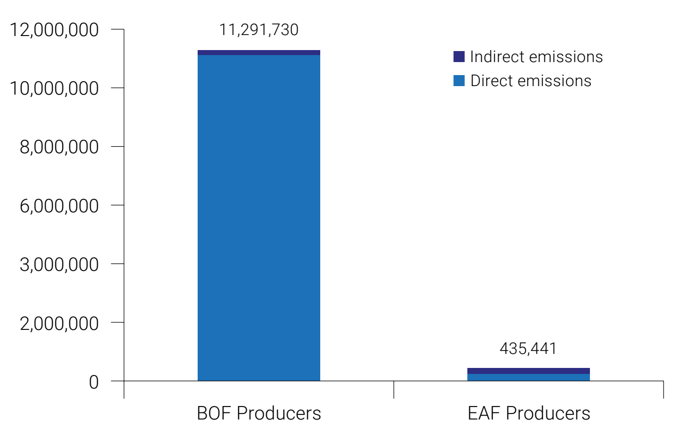
For recycled steel production in electric arc furnaces in the UK, around half of the emissions arise indirectly through the consumption of electricity, with the remaining emissions resulting from the use of natural gas and releases of carbon from the use of ferrous alloys and scrap, consumption of electrodes and steam generation if applicable[16]. The specific ratio will evidently depend on and be driven by the carbon intensity of the national electricity grid. As with the ore-based steelmaking process, emissions also arise from the processing of steel, secondary metallurgy, casting, and hot rolling. In 2020, indirect emission (i.e., emitted through electricity production, off-site) made up 3% of the sector's overall emissions, but about half of emissions from scrap-based production (see figure 7). Direct emissions account for 98% of emissions for the ore-based sites, with only 2% indirectly from grid electricity consumption. For recycled steel, depending on the specific production site, direct and indirect emissions make up around half each. Overall, scrap-based steel production accounted for 4% of total steel sector GHG emissions, with the ore-based production sites accounting for 96% of emissions. The decarbonisation route for EAF is thus more straightforward,

**Figure 6 – Typical emissions in the global production of blast oxygen steel (ore-based production)**



*Source: Carbon Trust, International Carbon Flows – Steel, February 2011. Please note that these figures are from 2011, with the more recent data from 2018 proposes an average emission rate of 1.85 $tCO_2e$/tonne of steel (excluding the mining).*

**Figure 7 – Direct and Indirect emissions, UK steel production, 2020**



*Source: Direct emissions: EU ETS registry. Indirect emissions: Electricity consumption from International Steel Statistics Bureau; grid carbon intensity from Electric Insights.*

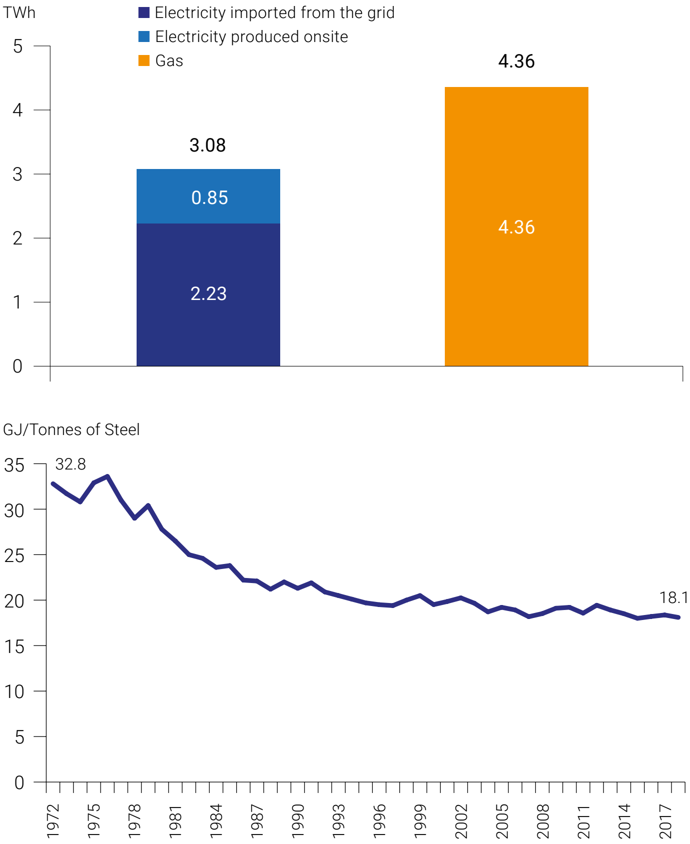
as a large proportion of the emissions will reduce as the electricity supply is decarbonised. The ore-based sites emitted 1.97 tonnes of $CO_2$ per tonne of crude steel, compared to scrap-based production of 0.32t$CO_2$/tCS in 2020.

The steel sector's sizable energy consumption contributes to its emissions, with 3.08TWh of electricity consumption, 4.36TWh of natural gas consumption, and 2.9m tonnes of coal and coke in 2020[17]. The energy efficiency of the UK steel sector has improved dramatically over the past 50 years, with a 45% reduction in energy consumption per tonne of steel, through continuous improvement in energy efficiency and plant optimisation. However, the decline has slowed since the 1990s, as the theoretical limit has been reached, showing the requirement for step-change breakthrough technologies.

Historically, the sector's *direct* emissions have fallen from almost 25Mt to 11.3Mt of $CO_2$ in 2020, as illustrated in figure 9.

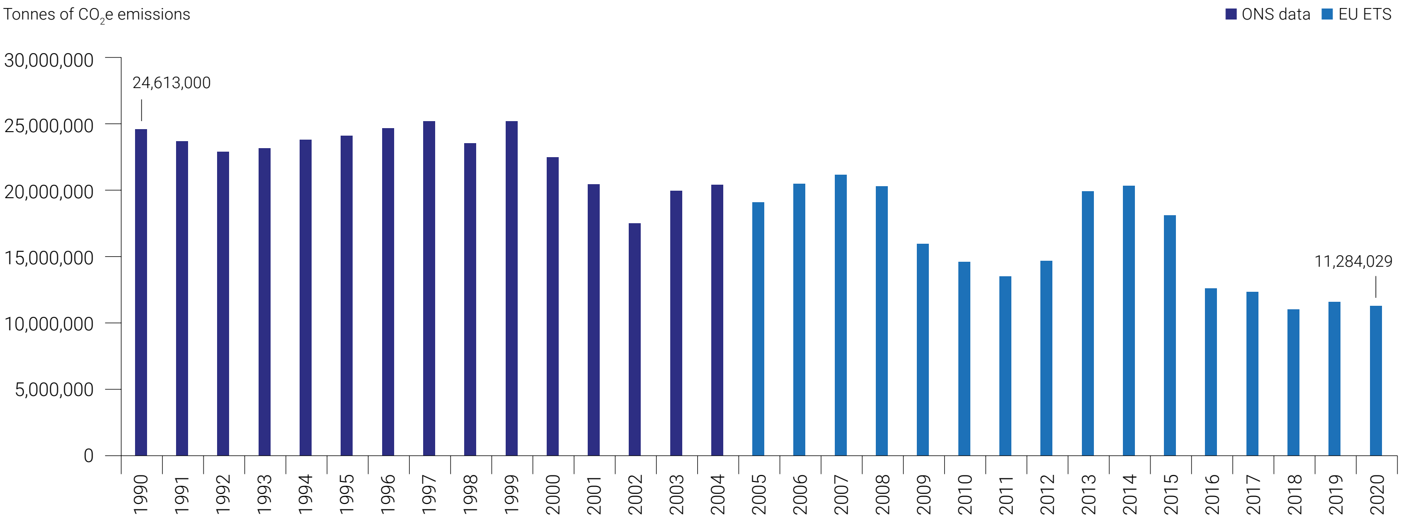
The 11.7Mt tonnes of direct and indirect $CO_2$ emissions related to UK steel production in 2020 constituted 11.1% of industrial emissions and 2.6% of all UK GHG emissions in 2020[18]. This makes the steel industry the fourth largest emitter by sector, and the two ore-based steel production sites (Port Talbot and Scunthorpe) are the two largest industrial sources of carbon emissions in the UK.

### Figure 8 – UK steel electricity and gas consumption 2019, and energy consumption per tonnes of steel, 1972-2018



*Source: International Steel Statistics Bureau, UK Steel*

### Figure 9 – Direct emissions from UK steel production, 1990-2020



*Source: ONS 1990-2004, EU ETS register 2005-2020*

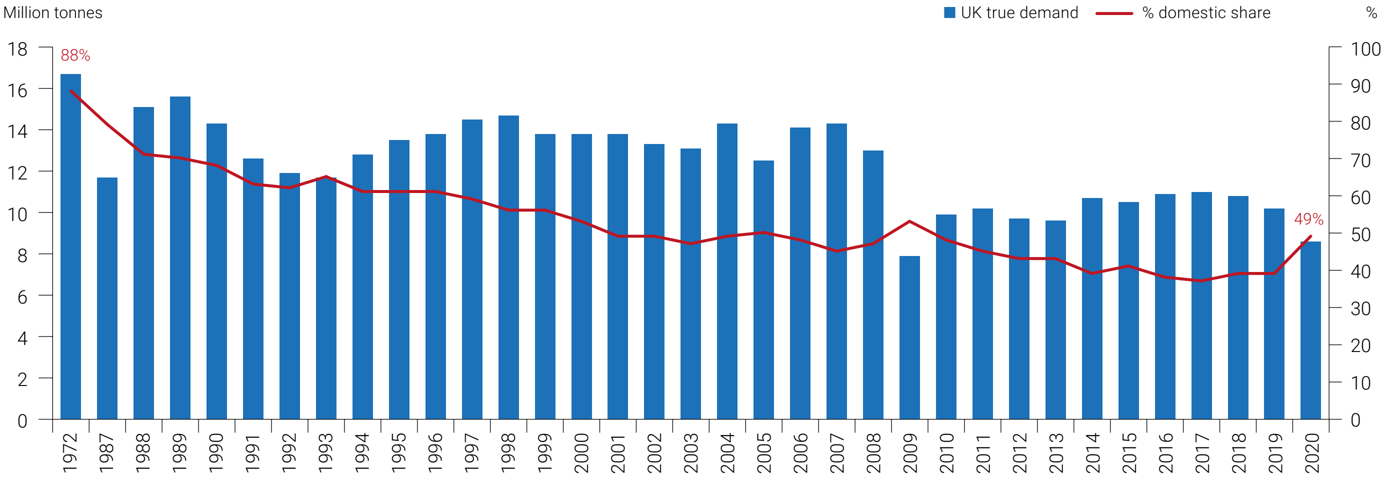
## 6.1. Territorial vs Consumption Emissions

The above section details the emissions related to steel production that occurs in the UK. However, this is far from the complete picture. Steel is an intensively traded product, with 30-40% of the 1.9 billion tonnes of steel produced each year globally travelling across national borders. The UK imports some 6.6Mt of steel each year, around 60% of requirements, and exports 3.5Mt just under 50% of its production. As such, to gain a complete picture of the UK's steel-related emissions, imported steel and steel containing products must be accounted for. Related emissions must be split between territorial-based (i.e., emissions arising from domestic production) and consumption-based (i.e., emissions arising from all the steel products and services the UK consumes).

Figure 10 shows the UK's annual direct demand for steel (i.e., excluding steel containing products), alongside the domestic share of this demand. In 1972, steel demand was 16.7m tonnes, of which 88% was met by domestically produced steel. By 2019, UK direct demand for steel had reduced to 8.6m tonnes, with 49% of this demand met by domestic production. The higher level in 2020 is largely driven by the economic impact of Covid-19, with the domestic share previously being 39% in 2019.

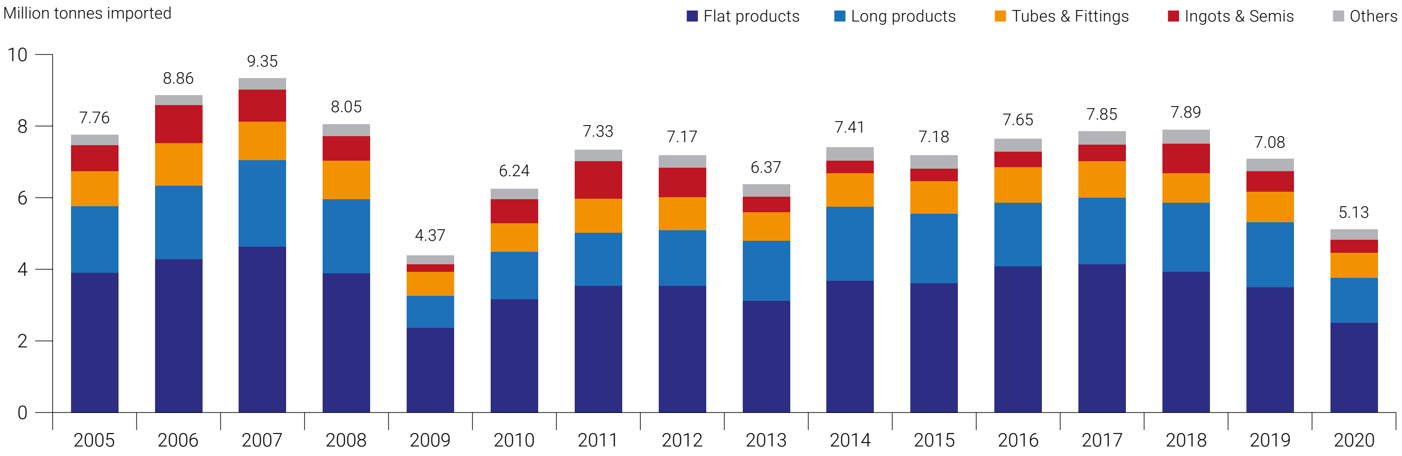
Figure 11 shows the imported steel over the past 15 years, showing a consistent level of imported products between 7-8 million tonnes except during the financial crisis and the 2020 Covid-19 lockdown.

### Figure 10 – UK apparent steel demand and domestic share



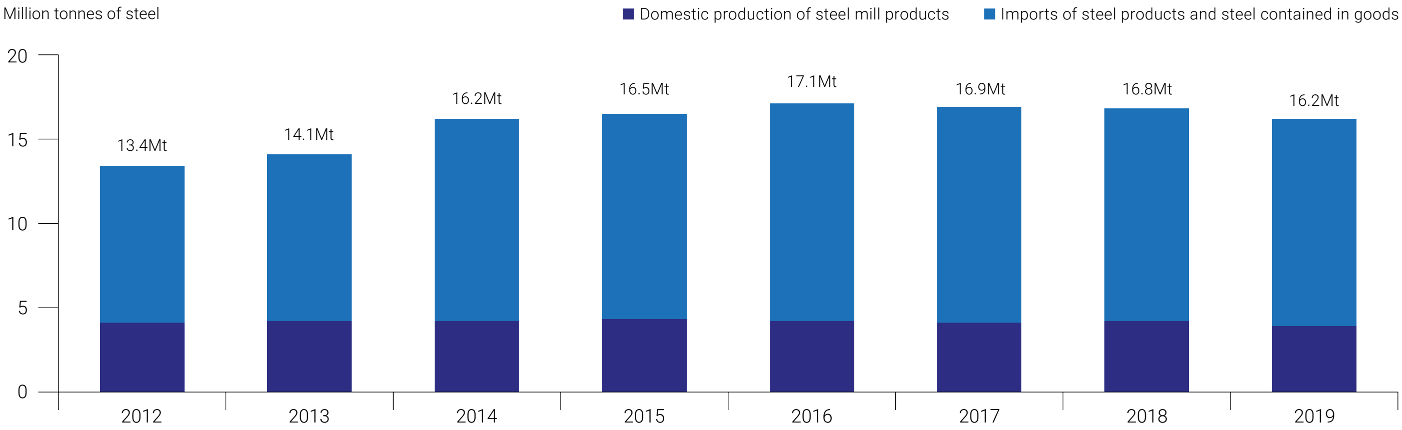
*Source: International Steel Statistics Bureau. The demand figure does not include wire, castings, forgings, or steel embedded within imported products.*

### Figure 11 – UK import of steel products



*Source: International Steel Statistics Bureau*

## Figure 12 – UK true demand for steel, 2012-2019

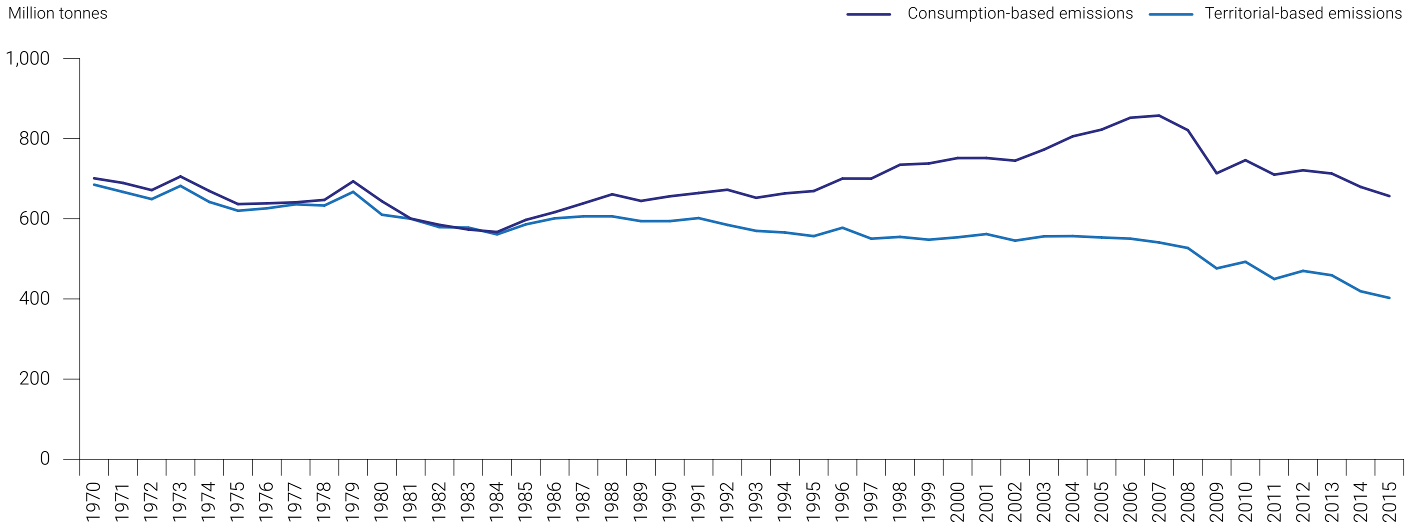


*Source: International Steel Statistics Bureau, WorldSteel*

Similarly, figure 12 illustrates the UK's true steel demand when considering the imports of steel contained in goods, such as cars, washing machines and tinned goods. This shows that the actual steel demand of the UK is closer to 16 million tonnes annually, with around 40% of consumed steel being contained in imported goods. Such considerations must also be considered when devising a workable decarbonisation policy.

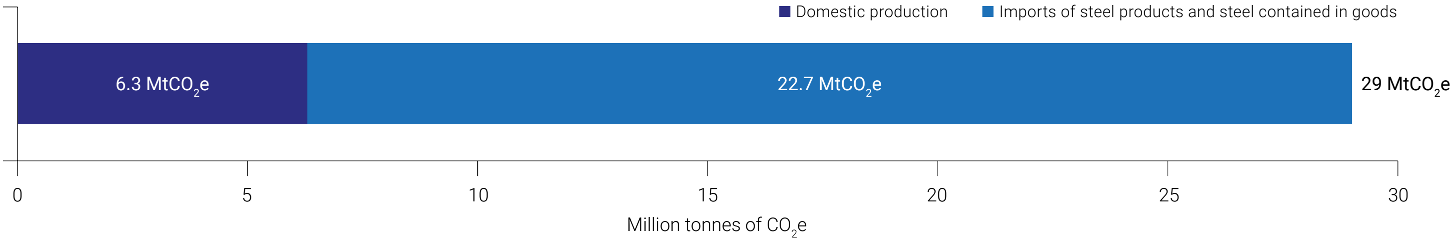
The reduction in territorial emissions often leads to claims that the UK has significantly reduced its greenhouse gas emissions since the 1990s. However, this does not take account of the consumption-based emission embedded in imported goods and services. The reduction in the UK's territorial emissions has occurred in conjunction with a shift in the economy from "more carbon-intensive manufacturing to less carbon-intensive service-based industries"[19]. In 1948, the manufacturing sector contributed 33.1% of UK GDP and the service sector 50.8%, but in 2016, the manufacturing industry contributed 10% to GDP, with the service sector contributing 79.6% of UK GDP. As shown in figure 13, when taking embedded emissions in imported products into account, the UK's rate of greenhouse gas emissions has not reduced since 1990, and only barely since 1970, though it has reduced since 2007. Compared to other G7 countries, the UK is the largest net importer of carbon dioxide per capita[20].

## Figure 13 – Different measures of $CO_2$ emissions, 1970 to 2015, UK



*Source: Office for National Statistics[21]*

## Figure 14 – UK steel estimated consumption emissions, 2019



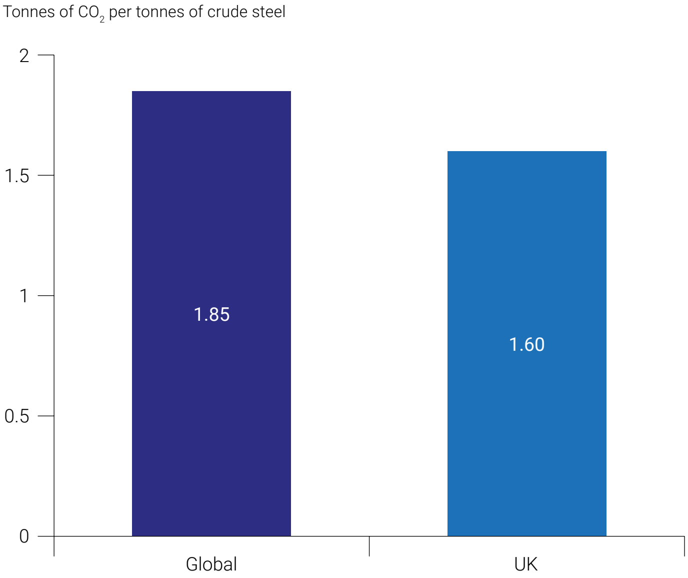
*Source: UK Steel analysis. Direct emissions: Domestic production to the home market, EU ETS; Imported emissions: World Steel. Note: True steel use is obtained by subtracting net indirect exports of steel from apparent steel use to include imported and embedded steel products. The domestic emissions are calculated by subtracting exported steel emissions. A weighted average emission intensity of 1.85tCO$_2$/tCS has been used for imported emissions, and 1.6tCO$_2$/tCS for UK steel.*

This is significant for the UK consumption of steel and the decarbonisation of its production. In 2019, the UK consumed 16.2Mt of steel, when accounting for steel embedded in imported products, which would suggest that UK consumption of steel is responsible for 29m tonnes of CO$_2$e (see figure 14). The current policies do not fully address the emissions connected to the imported and embedded steel and ignore two-thirds of the UK's steel-related emissions.

In decarbonising the steel sector, the current approach has been to price carbon through the EU Emission Trading System (EU ETS) and now the UK Emission Trading System (UK ETS). However, as steel is highly trade-intensive, additional costs from emission trading schemes reduce the ability of domestic steel operators to compete with international competitors and can instead lead to an increase in imports of higher-carbon, lower-cost steel. As such, higher carbon pricing from the EU and UK ETS would only lead to a shift of the emissions from the UK to abroad, from the direct UK emission to higher imported and embedded emissions.

Increased reliance on steel imports could lead to higher emissions if imported steel is produced in a more carbon-intensive steel plant. Global carbon intensity varies from 0.29-3.38 tonnes of CO$_2$ per tonnes of crude steel, depending on plant efficiency and production method (i.e., ore-based vs scrap-based).

## Figure 15 – GHG Emissions per tonne of steel produced



*Source: WorldSteel, EU ETS, and UK Steel*

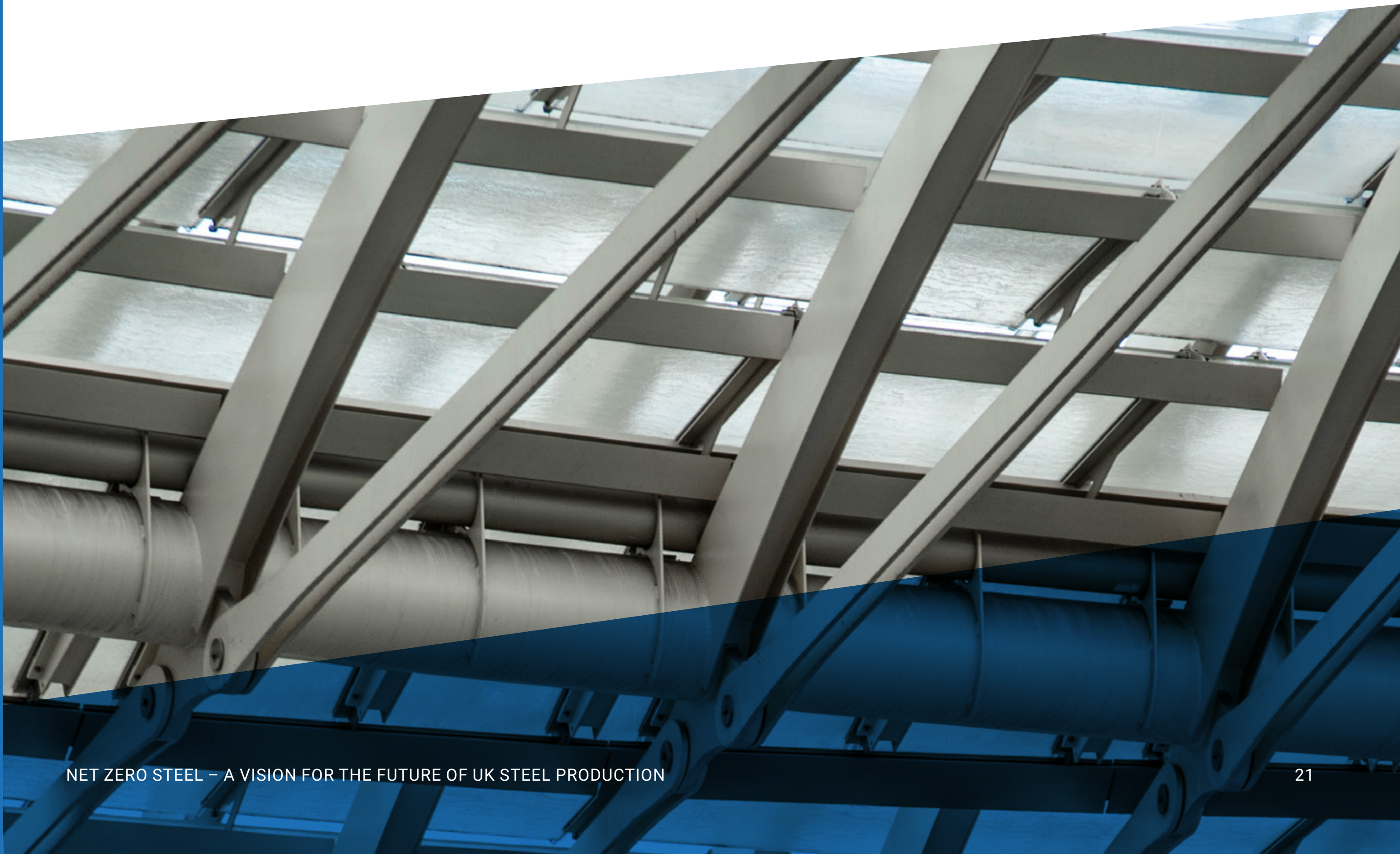
UK ore-based producers emit **16% less $CO_2e$** than the global average BOF producer.

Scrap-based producers emit **49% less $CO_2e$** than the global average EAF producer.

Separating the production methods, UK steel ore-based sites emitted 1.95t$CO_2$/tCS, compared to the global BOF average of 2.33t$CO_2$/tCS (16% less). UK scrap-based production emitted 0.35t$CO_2$/tCS compared to the global average of 0.69t$CO_2$/tCS, which is 49% less than the global average EAF production. The weighted average for global steel production is 1.85t$CO_2$/tCS in 2018, and the UK steel average is 1.6 t$CO_2$/tCS. However, the global average also includes DRI-EAF, and unconventional processes such as charcoal blast furnace, multiple hearth furnace, Corex, and FINEX, making it more difficult to compare.

As UK steel production sites are less carbon-intensive than the global average for both ore-based and scrap-based steelmaking[22], increases in imports will likely lead to a rise in global greenhouse gas emissions. This is also supported by Professor Julian M Allwood in *Steel Arising*, where he states, "global emissions would be lower if UK final demand were met by UK blast furnaces rather than those elsewhere"[23]. Additionally, increased imports of finished steel products will also boost transport-related emissions – for example, shipping a tonne of product from China will result in an estimated 0.3t$CO_2$[24]. The precise net impact on transport-related emissions of increased imports compared to domestically produced steel is more complex and must take account of the shipping of raw materials to make the steel and the density of products. However, given that most ore-based producers in the world import raw materials and significant quantities of steel in the UK are produced from domestically produced scrap it is evident that transporting increasing volumes of finished steel products to the UK would lead to more emissions than transporting raw materials and produce steel products in the UK. This is also reflected in the Government's Industrial Decarbonisation Strategy, where the Government states its aim to avoid offshoring industrial production and its emissions.

Given this picture of lower production and transport-related emissions from domestically produced steel, it must be a clear policy aim to encourage and facilitate the greater use of UK-produced steel. With a well-devised industrial decarbonisation policy framework it will be possible to drive those steel-related emissions towards zero in the years ahead. This is the only way to tackle the UK's steel-related emissions in a meaningful manner that targets a reduction in global emissions, rather than simply one regarding UK territorial emissions.



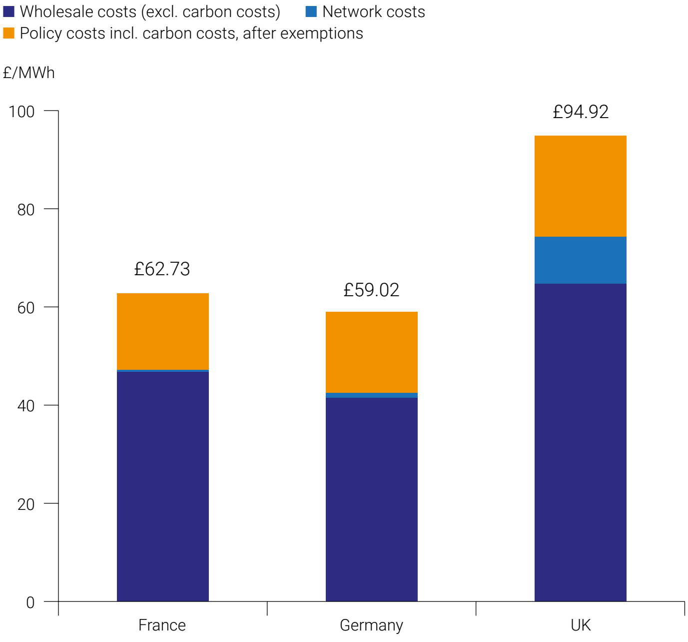
# 7. CHALLENGES

## 7.1. Electricity prices

The UK steel industry faces some of the highest industrial electricity prices in Europe, which damages its competitiveness, as it is both electro-intensive and highly exposed to international competition, meaning it cannot pass on additional costs to customers. The average electricity price UK steel producers typically faced in 2021/22 is £94.92 per megawatt-hour (MWh) compared to the estimated German price of £59/MWh and French price of £62.73/MWh. UK production sites are therefore paying 61% and 51% more, respectively, than their main competitors[25]. The disparity in electricity prices is after receiving the compensation and exemption packages that UK steel producers are eligible for, and French and German equivalent programmes have also been applied.

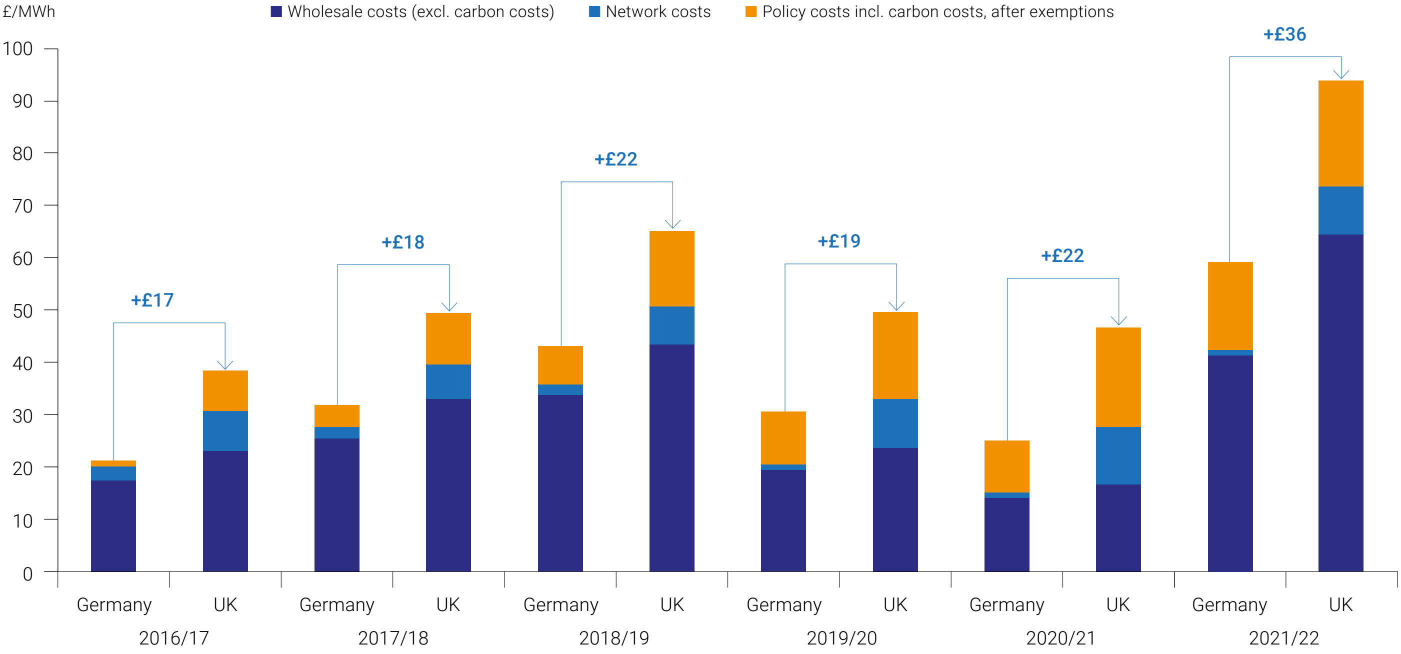
The price disparity is primarily caused by lower levels of exemption from renewable levies in the UK, additional exemptions for network charges in Germany and France, and additional UK carbon pricing through the Carbon Price Support. The price disparity has increased as a result of the substantial increase in gas prices.

**Figure 16 – Electricity prices for steel producers in France, Germany, and the UK (2021/22)**



*Source: UK Steel*

**Figure 17 – Comparison of Electricity prices for the UK and German Steel producers 2016/17 to 2021/22**



*Source: UK Steel*

The Government has announced increases to the indirect compensation for carbon costs and separately a consultation on increasing the renewable levy exemption rate. This will partly reduce the disparity in electricity prices and is warmly welcomed by industry. However, these initiatives and action on network charges and Capacity Market levy will be needed to reduced the price gap even further.

Electricity costs can represent up to 120% of UK steel producers' GVA and around 20% of their conversion costs[26], i.e., the costs of converting the basic raw materials into steel. The price disparities equate to a total additional cost to UK steel producers of around £90m per year compared to those in Germany, which directly hampers the industry's ability to make investments in decarbonisation. The indirect impact is on long-term investment, as all major steel producers in the UK are part of multi-national companies with facilities elsewhere in the EU and four also operating outside the EU. In this context, the cost competitiveness of each particular market is crucial to attracting investment. Persistent cost disadvantages in the UK lead to underinvestment, which leads to further erosion of competitiveness.

All options for decarbonising the steelmaking process leads to increased electricity consumption. At a capture rate of 15-28%, deployment of CCUS lead to 8-15% increased energy use, which would grow at higher capture rates. Scrap-based production has a grid-electricity consumption over two times higher than ore-based production, and hydrogen-based steel production would increase the entire sector's electricity demand by almost 250% if using blue hydrogen (or almost 800% if based on green hydrogen). With the current disparity of £35.90/MWh, it would cost £198m more to operate an electrified steel sector in the UK than in Germany or £298m more to operate a hydrogen-based steel sector. As such, it would be difficult to see investment in decarbonisation in the UK over its key European competitors. Instead, investment would flow towards the most cost-competitive market. Lower industrial energy prices are a basic necessity for the industry to start decarbonising its production.

## 7.2. Business and economic challenges

The greatest challenge for the steel sector in decarbonising is the current lack of a credible business case. As set out above, technologies such as electrification, hydrogen-based steelmaking, CCUS, and fuel substitution in downstream processes will require significant capital investment in addition to the regular asset's maintenance costs. Even once this has been recuperated, the operational costs for hydrogen-based and CCUS ore-based production would be much higher than traditional, more carbon-intensive forms of steel production. Scrap-based production would not have significant higher OPEX but would have its own challenges (outlined below).

Massive increases in CAPEX and OPEX would be viable if all steel production globally were subject to the same pressures to reduce emissions, and therefore all producers were required to make the same investments and increase their operational costs by comparable amounts. The result would be that the global cost of steel would increase, prices would rise for consumers, as they would face the carbon cost for the steel they consume, and steelmakers could continue to be profitable.

However, there are varying levels of climate change ambition and regulations in place in different steel-producing countries. If UK producers make the necessary investments and changes to their production processes, they will be undercut in the market by lower-cost, more-carbon intensive steel producers. No business will make investments of the magnitude required in these circumstances, and if forced by regulations (i.e., through the imposition of carbon taxes on production alone), the economically rational decision would be to cease production in the UK rather than make those investments.

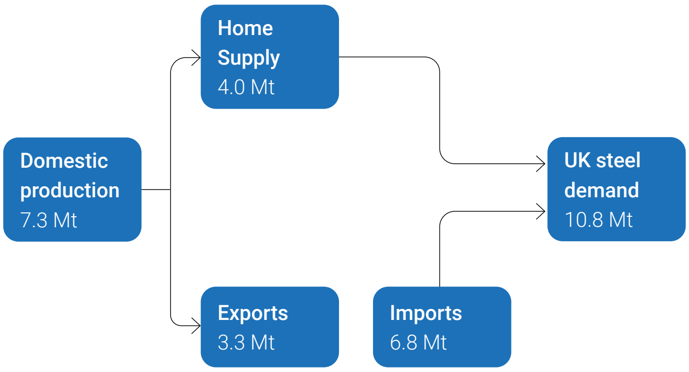
The steel sector needs tangible market advantage and clear policy signals similar to the policy direction provided to the automotive market, where targets have been set for the phase-out of petrol and diesel vehicles. Automotive manufacturers know that by 2035 they will no longer be able to sell these products in the UK market, and as such, there is a clear incentive to invest and innovate to create a new range of products that can be sold in what will become an exclusively low-carbon vehicle market. The need for a clear policy signal and market advantage is recognised by the Government in the Industrial Decarbonisation Strategy. Similarly, renewable deployment in the power sector only happened because of government intervention (the Renewables Obligation, Contracts for Difference, Feed-in-Tariffs) in addition to the EU/UK ETS and Carbon Price Support that allowed generating companies to profit from clean power production. However, it is worth acknowledging the difference between the automotive market, where the UK discriminates based on the function of the product (i.e., electric vs combustion engine), and the steel sector, where it is proposed to discriminate products with the same function based on the method of manufacturing. Some policies are currently being developed to address this (e.g., the business models for CCUS and hydrogen production).

These interventions have been taken because they impact the UK's territorial emissions and therefore have been deemed necessary. The UK could theoretically import all its steel from elsewhere and meet its net zero carbon targets, which would meet the letter of the law but not lower global emissions. Territorial emissions would be lowered in the UK, but UK consumption emissions relating to its use of steel would remain or even increase, depending on from where steel was imported. Instead, industry and Government must develop policies that create a market for low-carbon steel and allow steel companies to profit from supplying into it.

Without a global carbon price applied equally to all producers, there are two basic options:

- **Create a market for low carbon steel in the UK.** This could take the form of product standards that stipulate a maximum GHG footprint for steel sold and used in the UK or enact Carbon Border Adjustment Mechanism that ensured that imported high-carbon steel would be taxed comparatively. The former would be like the automotive sector approach where increasingly stringent emissions standards are required, ultimately leading to the complete phase-out of petrol and diesel vehicles by 2035. The latter is being consulted on in the EU and would act to level the playing field in carbon costs between domestic and foreign producers.
- **Subsidise the production of low carbon steel in the UK**. This is broadly comparable to the power sector approach, where energy consumers pay a levy directly to low-carbon energy generators that allow them to be cost competitive with traditional, higher-carbon forms of power generation.

**Figure 18 – UK Steel Supply and Demand 2019**



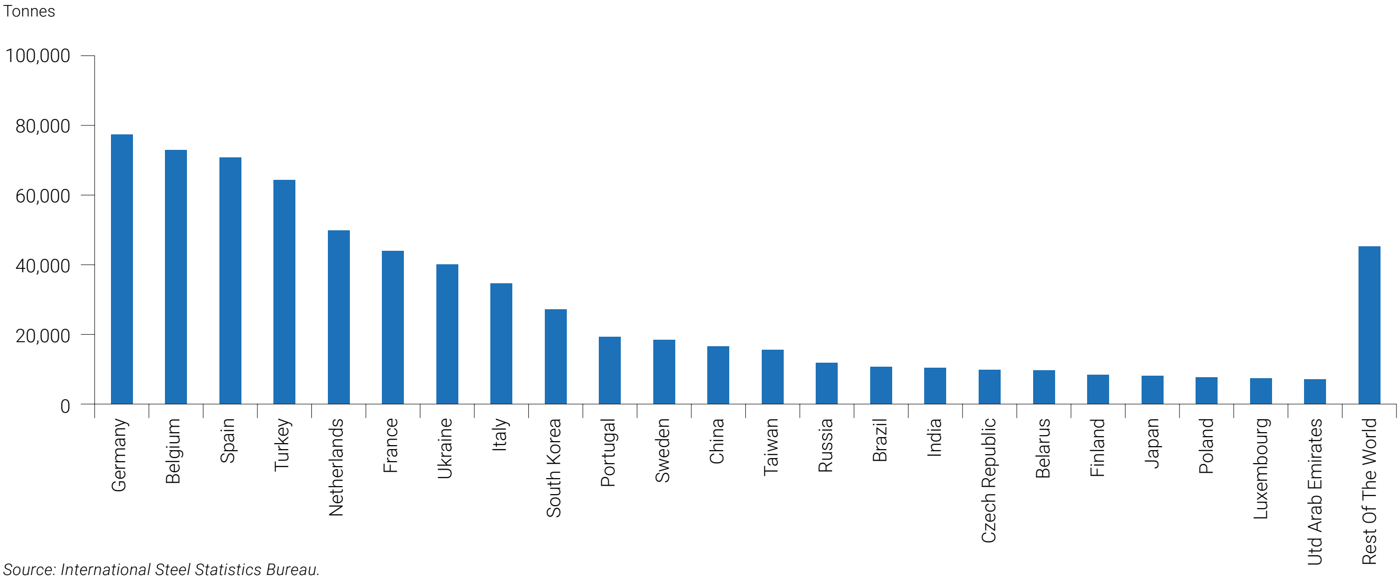
*Source: International Steel Statistics Bureau*

## 7.3. Trade challenges

At the heart of the business and economic challenges above is one of international trade. Steel is a global commodity, intensively traded across borders. 25% of all steel produced is trade internationally, this climbs to 43% in markets outside of China, whilst the UK exports 45% of its steel production and imports over 60% of its direct requirements (i.e., not include steel in products). UK steel import penetration (i.e., the percentage of steel demand supplied by imports) has climbed from around 12% in the 1970s to 63% last year due to a rapid increase in global trade, the removal of tariffs on steel products amongst developed nations, manufacturing supply chain integration across the EU, and a gradual decline in the UK's overall steel production capacity.

The UK imports its steel from an increasingly wide range of countries. Whilst the vast majority come from the EU, mainly due to geographic proximity and integrated supply chains, countries such as Turkey, South Korea, China, Russia, Brazil, and India are all major exporters to the UK now – each supplying over 100,000 tonnes a year and with Turkey providing as much as 643,000 tonnes in 2019 – almost 10% of imports and 4% of total demand.

**Figure 19 – Sources of UK Steel Imports 2019**



*Source: International Steel Statistics Bureau.*

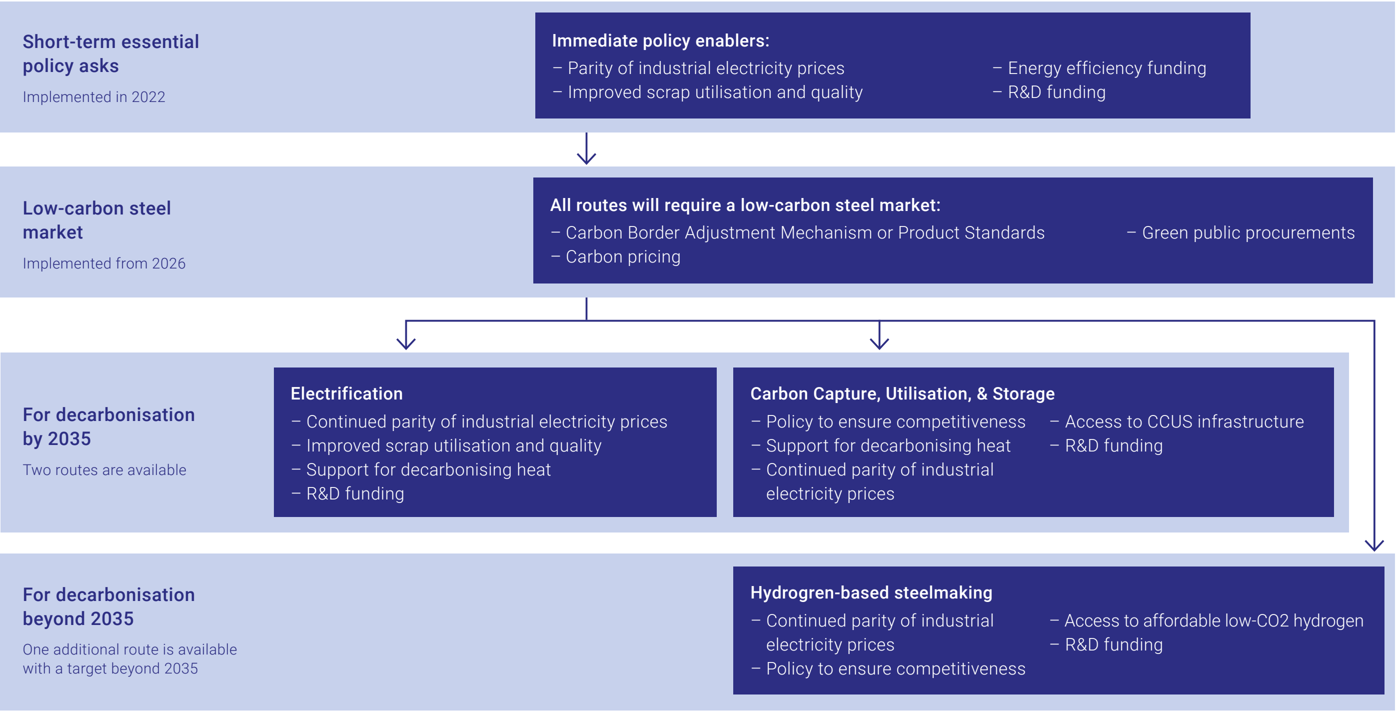
With such high levels of international trade in steel, constructing a workable industrial decarbonisation policy in the UK is not straightforward. Simple mechanisms such as emissions trading and carbon pricing that tax the emissions of domestic producers create an uneven playing field when those countries exporting to the UK have not applied comparable policies. For example, a UK carbon price of just £50/t$CO_2$ would increase production costs for BOF plants in the UK by around £80/tonne of steel. Recouping this cost would require a 10-20% increase in prices charged to customers, and almost without exception, those customers will instead turn to imported products to keep their costs to a minimum. In the absence of any global mechanism, national and regional carbon pricing are far better suited for sectors where there is no real alternative but to produce the product domestically, where consumers cannot readily turn to imported alternatives; electricity generation being the obvious example here.

The EU ETS and now UK ETS have attempted to mitigate this particular challenge by providing the most carbon and trade-intensive sectors, such as steel, with 'free allocations' of carbon allowances. This has, by and large, maintained a level playing field between domestic producers and exporters to the UK, but this, and several other failings of the trading system, have still failed to provide the all-important business case for the investment required. The power sector is a good example, where additional policies had been brought in, such as Contracts for Difference, the Renewables Obligation, and the Carbon Price Support, to deploy low-carbon power generation.

In devising a workable industrial decarbonisation strategy and building a business case for investment in clean steel production, steel producers must remain internationally competitive. It would not be sufficient to design policies to ensure UK producers remained competitive in their home markets. UK steel producers export over 40% of their products to markets worldwide and can only continue to do so whilst they remain competitive. Just as UK steel customers will not pay a 20% premium for 'clean' or 'green' steel, neither will those abroad. There are of course exemptions to the rule, with some companies publicly declaring their intensions to buy higher-cost, lower-carbon steel. However, as a whole, the market is not willing to pay an added cost for Net Zero steel.

# 8. TOWARDS DECARBONISATION

**Figure 20 – Decarbonising the steel sector and the needed policy changes**



**Short-term essential policy asks**
Implemented in 2022

**Immediate policy enablers:**
- Parity of industrial electricity prices
- Improved scrap utilisation and quality
- Energy efficiency funding
- R&D funding

**Low-carbon steel market**
Implemented from 2026

**All routes will require a low-carbon steel market:**
- Carbon Border Adjustment Mechanism or Product Standards
- Carbon pricing
- Green public procurements

**For decarbonisation by 2035**
Two routes are available

**Electrification**
- Continued parity of industrial electricity prices
- Improved scrap utilisation and quality
- Support for decarbonising heat
- R&D funding

**Carbon Capture, Utilisation, & Storage**
- Policy to ensure competitiveness
- Support for decarbonising heat
- Continued parity of industrial electricity prices
- Access to CCUS infrastructure
- R&D funding

**For decarbonisation beyond 2035**
One additional route is available with a target beyond 2035

**Hydrogren-based steelmaking**
- Continued parity of industrial electricity prices
- Policy to ensure competitiveness
- Access to affordable low-CO2 hydrogen
- R&D funding

Note: The hydrogen-based production requires electric arc furnaces, and the production route is therefore linked directly to further electrification and dependent on lower electricity prices as well.

First and foremost, the business environment needs to improve for the UK steel sector to put it in a sustainable position of growth and profitability, which will enable it to make significant investments in decarbonising its operations. Once this has been achieved, there are three routes available to facilitate the decarbonisation of steel production in the UK, depending on the required timeline. All three routes rely on establishing a low-carbon steel market, enabling costs to be passed on to steel customers. Figure 20 outlines the route towards decarbonisation for the UK steel sector.

## 8.1. Short-term measures

Several measures would greatly improve the business environment for the UK steel industry. It is vital that the steel industry is in a position of strength to be able to make the significant transition to a low-carbon production method. Below are the key recommendations for short-term policy changes:

### 8.1.1. Parity of electricity prices

A systemically higher electricity price is a substantial barrier to attracting investment into decarbonisation. There are several options for delivering parity of electricity prices with European competitors. There are, especially after leaving the European Union, no regulatory barriers to implementing the recommendations in the UK, since most of these are already implemented across the continent:

- **Implement German/French style network exemptions:** The UK should implement a 90% exemption to all three elements of network charging (transmission, distribution, and balancing) similar to what is provided in Germany and France for energy intensive industries. This would lower the average electricity price for steel producers by almost £10/MWh.
- **Increase the level of renewable levy exemptions:** The UK has provided relief at 85% aid intensity, whereas in Germany, companies achieving the necessary electro-intensity thresholds can access a higher level of relief – paying a maximum of 0.5% of their GVA (average over three years). The Government has announced that it will consult on this proposal in Summer 2022.

- **Provide an exemption from Capacity Market costs:** An exemption from Capacity Market charges would lower the average electricity price for steel producers by about £1.5/MWh, and a similar proposal is currently underway in Poland, where an 85% exemption will be provided.

With the recent announcement of changes to the compensation levels, great steps have been taken towards closing the gap. By implementing these final proposals, the price gap can be reduced even further.

The costs of these proposals should be socialised through general taxation, rather than spread across to other electricity consumers, and could be implemented within the following year. Interventions should ensure future parity of prices and protect against future disparities, if, for example, new costs were introduced, such as the Targeted Charging Reform for network charges. It is important to emphasise that it is the relative price that is significant, rather than the absolute.

As will be evident below, parity of electricity prices is not only vital to the short-term sustainability of the steel sector and its ability to attract investment to the UK, it is also fundamental to all decarbonisation routes. Competitive electricity prices will allow investment in hydrogen-based steelmaking, which depends on EAFs and electricity for hydrogen production; in CCUS, which is energy intensive and will increase electricity consumption; and in EAFs, which depend on electricity as their main energy source.

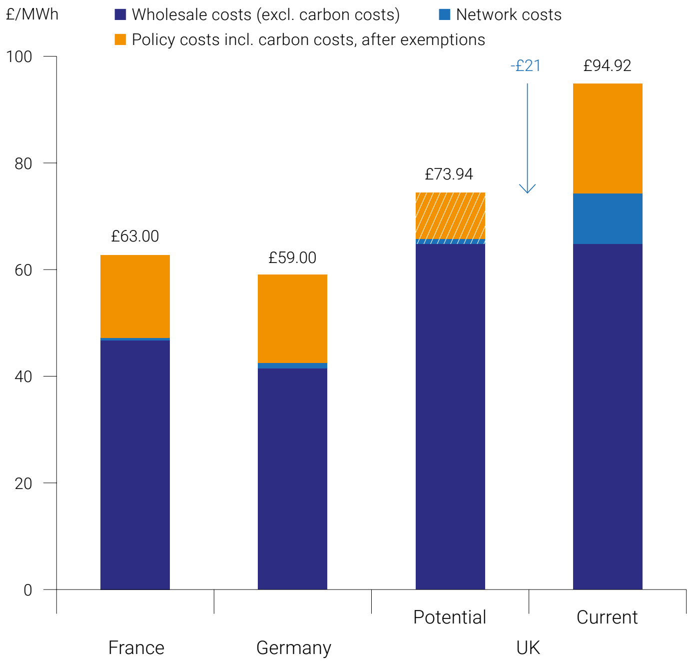
The parity of electricity prices will need to be delivered in 2022. The competitive power prices will be needed to attract the investment in long term decarbonisation (as explored below), and if delivered any later than end of 2022, it will be difficult to meet the outlined targets.

**Recommendation:** Deliver parity of electricity prices via the proposed approaches the end of 2022.

### 8.1.2. Financial support for energy efficiency

Industrial energy efficiency funding can help companies fund more capital-intensive investments in energy efficiency, particularly where payback periods are longer, and therefore the business case is lacking. It will help reduce overall operating costs for industry, unlock further capital investment for the UK, drive productivity improvements, reduce energy consumption and carbon emissions, and facilitate innovation and R&D in this area. The increased productivity and competitiveness would in turn facilitate further investment in decarbonisation since the cost-competitiveness of each market is crucial to attracting investment within the multi-national companies.

**Figure 21 – Potential electricity prices for UK steel producers, compared to France and Germany**



*Source: UK Steel*

The potential of energy and carbon efficiency is also evident from WorldSteel data collection, which shows the range of current carbon emissions from scrap-based and ore-based production. The top 15% of ore-based producers emit over 20% less $CO_2$ than the remaining 85% of producers, and the top 15% of scrap-based producers emit almost half the carbon than the remaining 85% of producers on a global scale. This illustrates the importance of programmes such as the World Steel Association's Step-Up Efficiency methodology that encourages all steelmakers to improve their operations to the level of the current top 15% of performers. There is excellent potential to enhance existing EAFs through heat recovery, scrap pre-heating, foamy slag practices, oxy-fuel burners or lancing, improved process control, flue gas monitoring and control[27], to name a few. Similarly, further efficiencies can be achieved in casting and secondary processes through, for example, continuous casting, efficient ladle preheating, near-net-shape casting, endless strip production, direct rolling, hot charging, improved insulation, walking beam furnace, and heat recovery from cooling water[28]. If CCUS is applied to blast furnaces, there are also great opportunities for efficiencies in all parts of the ore-based production via, for instance, heat recovery coke ovens, improved ignition oven efficiency with multi-slit burners or curtain flame ignition system, top pressure recovery turbine, improved BF gas recovery, and improved ladle preheating[29].

Lowering cumulative emissions is essential to mitigating climate change. Improvement to existing equipment and furnaces will reduce overall collective carbon emission from the steel sector, while improving overall efficiency and productivity, putting the sector in a better position to invest in decarbonisation technologies. This also becomes clear when considering that next generation furnaces such as HIsarna (see below) will likely not be available in time for the 2035 ambition, which emphasise the importance of improving the existing technologies through support for energy and carbon efficiency. There must certainly be a focus on no-regret investment to make sure the improvements are worth supporting, while considering the span of time of decarbonisation benefits.

This can be delivered through the Industrial Energy Transformation Fund within the next year or the Clean Steel Fund within the next two years. However, the existing funds have currently been challenging to access for the steel sector. Due to the very tight margins of the industry and the poor trading environment for the steel sector in the past few years, companies have struggled with even meeting the current 55-65% CAPEX funding requirements. It would be worth readjusting these requirements, considering the affordability challenges the industry has experienced.

**Recommendation:** Confirm the Clean Steel Fund, increase funding for industrial energy efficiency projects, and made them more accessible to the steel industry by 2023 at the latest.

### 8.1.3. Increased utilisation of scrap

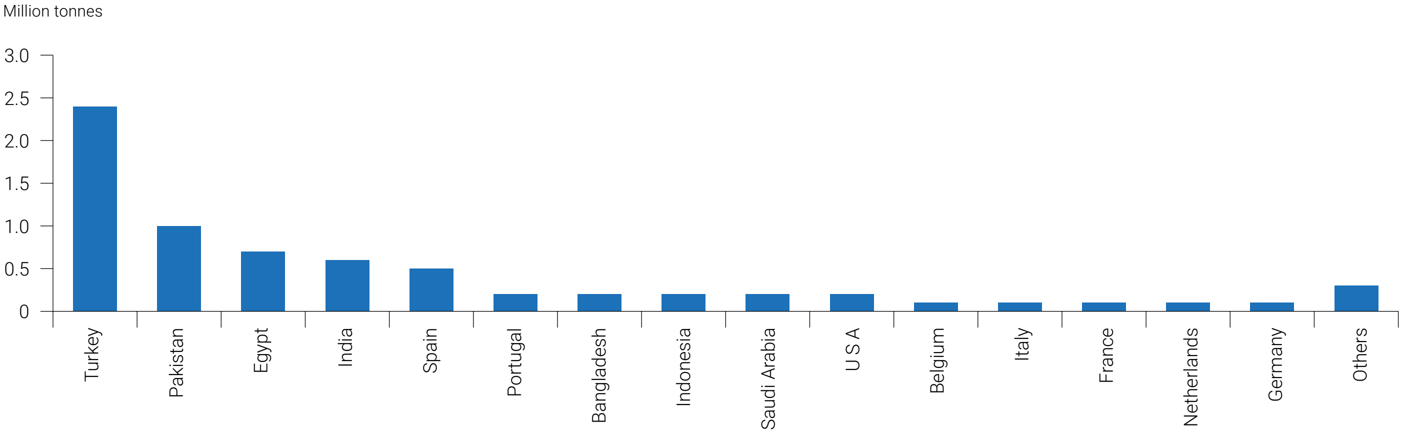
Steel scrap will become more critical as the industry decarbonises its production methods and existing scrap-based sites increase production. Therefore, steel producers and scrap merchants have a big task ahead of them to ensure that more steel is utilised in the UK and the quality of the scrap increases. Recycling rates of steel are already very high, with 96% of the steel used in construction and infrastructure in the UK being recovered and recycled[30]. However, while the UK generates in excess of 10Mt of steel scrap each year, nearly three-quarters of this are currently exported. In many cases, it is converted into new steel products abroad and re-imported.

The UK has an obligation to deal with its own waste, and the retention of scrap for consumption in the UK should be a cornerstone of the future development of the steel industry. Not only will it meet the objectives of reducing carbon globally by cutting transport emissions, but it will also enhance local recycling and the circular economy in the UK, and it provides the feedstock for the lowest carbon steelmaking available. In addition, it builds on the increasing need for self-sufficiency of the manufacture of key materials and provides the economic and social benefits of increased employment and industrial growth. Encouragement needs to be given to retaining scrap in the UK for end-users and the whole supply chain to value and promote the local use of scrap, ensuring that appropriate changes are made to existing business models and that unintended consequences are avoided. The UK has a global responsibility to retain its waste rather than export it to countries with lower environmental standards, such as Turkey and Pakistan, the two biggest importers of UK scrap.

As per figure 22, most scrap is exported to countries with lower environmental standards than the UK and EU markets.

The Turkey 2020 Report for the EU Commission[31] finds that Turkey is not aligned with the EU (and thereby the UK) on critical environmental regulations. Air quality legislation needs to be agreed in line with EU national emissions ceilings and air quality directives; implementation of water quality regulations and its enforcement should be improved; alignment with the Industrial Emission Directive is awaiting; the Paris Agreement

**Figure 22 – Export of steel scrap, 2020**



*Source: International Steel Statistics Bureau*

is yet to be ratified, and national ambitions on emission reduction are not aligned with EU targets; and finally, waste management plans need to be implemented on a regional and local level. This demonstrates that the leading importer of British scrap is far behind the UK on environmental and climate regulations. This is, for example, also the case for India, where emissions to water and air can be many times higher than current UK regulations[32].

As the steel producers decarbonise, their use of scrap will likely increase significantly (either through use in Blast Furnaces, by converting to EAF, or in combination with hydrogen-based production), in addition to increased production at current EAF sites. Naturally, an increase in demand for scrap will lead to an increase in scrap price, especially when UK producers compete for the scrap with producers abroad. Steel producers abroad have lower running costs due to lower environmental and H&S standards. The steel and metal recycling industry must work together to find common solutions.

Separately, it is also important to improve the sorting, segregation, and separation of scrap (principally the physical contamination of other non-ferrous items) to ensure the best value retention. The lower-quality scrap reduces productivity and increases costs and emissions.

Anecdotal evidence from steel producers shows that the iron content varying from 70% to 95% and some report high levels of contamination. The lower quality product causes yield loss, excess flux/alloy use, temperature losses, and high residuals in the liquid steel.

Other countries are looking to limit scrap being exported to countries with lower environmental standards. The UAE temporarily banned ferrous scrap export in May 2020 for eight months, and South Africa has previously prohibited scrap exports. Russia has an export duty on ferrous scrap, which it increased to a minimum of €100-290 per tonne[33]. Before the Russian invasion, Ukraine had increased its long-standing scrap export tariff to €180/t in December 2021.[34] Finally, the European steel trade body, Eurofer, has similarly called for action on scrap exports from the EU.

The UK Government must work with scrap merchant and the steel industry to (1) ensure UK circularity by retaining valuable raw materials such as ferrous scrap in the UK to process them to new steel products; (2) provide a level playing field on sustainability; (3) ensure effective enforcement of current regulations on exports of waste.

An immediate intervention could be made which would help UK retention of scrap:

- **Removal of Export Packaging Recovery Notes:** The ePRN currently offers price support to scrap exports. The DEFRA consultation on waste is indicating the discontinuation of PRNs in general. If this export incentive were eliminated immediately (whilst UK PRNs continued), more scrap would be retained for UK consumption.

Current recommendations for policies designed to encourage higher domestic consumption of scrap:

- **Environment Bill:** Use the powers within the Environment Bill, which empower the Secretary of State to issue regulations covering the export of waste (clause 61) to prevent steel scrap waste from being exported to economies with lower environmental standards.
- **Support for improved scrap sorting techniques and technologies for UK recycling purposes:** Additional funding for scrap sorting techniques to improve processing, identification, and separation. This should also include R&D support for removing problematic elements from the scrap pool and new casting technologies, which could produce higher-quality products from less controlled steel compositions.
- **Domestic Incentives:** Incentives for the supply chain to commit to and ensure domestic recycling of steel scrap. The main thrust would be to promote and encourage UK recycling, including the potential relocation of existing assets to areas of scrap generation or usage. Ultimately, a tariff on exporting scrap could ensure provision for UK consumption.

**Recommendation:** Implement new measures to increase utilisation of scrap.

#### 8.1.4. R&D Support

The challenge of decarbonising the steel sector presents an historic technological and commercial opportunity that necessitates unprecedented investment in research, innovation and demonstration projects. Fortunately, in the area of R&D, the UK steel industry is not at a standing start and has an opportunity for Global Leadership as we build back better. The UK Steel industry benefits from a world class and innovative UK community from academia, RTOs and industry to support it which is regionally distributed and an essential component in the levelling up agenda. This has been carefully cultivated over decades by the industry through historical investments in commercial R&D centres across the country and the development of strategic relationships and collocation agreements with RTOs and Universities. Today, UK Steelmakers support over £214m in active UKRI research programs, tangibly demonstrating their strong and ongoing commitment to R&D.

However, many of the key technologies identified herein (for example hydrogen-based steelmaking or CCUS) are at an early stage of development. If a sustainable Net Zero transition is to be achieved, it is imperative that industry be facilitated to build on the strong R&D foundations it has developed to maximise the unique and transformational opportunities available to it.

This launching pad combined with the unique environment for domestic resources in both materials and renewable energy has the potential to deliver significant international competitive advantage in the production of clean steel. A Net Zero UK steel sector can therefore become a world-leading one, using best in class technologies and requiring UK steel plants to be amongst the most efficient in the world. To aid this transition and to develop many of the technological solutions here in the UK, it is proposed that industry and Government come together to form a **Clean Steel *Innovation* Fund**. This should be consulted upon in 2022 and open for applications in 2023.

#### 8.1.4.1. Funding

At the end of last year, UK steel companies lost access to the EU Research Fund for Coal and Steel, with the UK Government confirming previous summer that it will not fund those organisations choosing to participate in projects as 'third country' organisations[35]. According to the terms of the EU Withdrawal Agreement (Article 145), the approximately £180m UK share of this fund will be returned in five annual instalments from June 2021. This money was provided by a levy on UK steel and coal companies over the course of our membership of the European Coal and Steel Community and being industrial funds can provide up to 100% funding in the field of steel. The creation of the Clean Steel Innovation Fund provides the opportunity to align this funding with further government and new industrial investment to accelerate modernising and decarbonising the steel sector.

It is proposed that the fund is administered by the industry itself with the relevant government oversight. This permits the agility and flexibility to meet demanding Net Zero targets but critically also ensures a degree of stability in funding that is essential to maintain the expertise and knowledge that will be contingent on meeting the UK's targets. Through projects such as SUSTAIN and PRISM, the industry already has significant track record in the development of robust governance processes that have, even in their early stages, levered significant additional funding and value for money. These projects demonstrate the commitment of the industry to an open and transparent approach with respect to the wider academic and innovation community, funding projects on the basis of quality, impact and alignment to the interests of the whole steelmaking sector. These existing and trusted processes can be used to administer these funds and can support the broad innovation platform required to deliver industrial transformation.

This approach combined with the current and future projected UKRI Net Zero Innovation Portfolio (open to a wider range of sectors with similar production and energy challenges) will provide a platform on which the UK can become a global leader in net zero steel technologies.

#### 8.1.4.2. Innovation Focus

It is proposed that the Clean Steel Innovation Fund is focussed on three core themes:

**Transforming Primary Production:** The majority of direct emissions in the sector come from liquid steel production. The fund's first priority will be to develop technological solutions that decarbonise this part of production. This would include, but not be limited to:

- Capture and storage of carbon dioxide and conversion into new commercial products.
- Development of alternative (e.g. hydrogen-based) iron making technologies viable for the UK.
- Novel steelmaking practices, scrap sorting, and digital technologies that increase scrap use.
- Improvements in product capability of electric arc furnace produced steel.
- Innovative conversion of biproducts (gases, slags, and other wastes) to value added products

**Energy Efficiency and Downstream Steam Processes:** The fund will also have a crucial role to play in decarbonising the downstream processes within the sector and improving the energy efficiency of all processes. Activities would include:

- Decarbonisation of rolling and heat treatment processes that use reheating furnaces, including conversion to alternative fuels
- Heat capture, re-use and recovery for industrial, and community heating schemes
- Embracing machine learning and artificial intelligence to improve process performance using novel in line sensors
- Deployment of novel energy efficient heating processes (NIR, photonic, induction) for rapid materials property transformation

**Steel Supply for a low carbon world:** Traceable, novel steel products with cutting edge properties designed for maintenance, re-use and recycling will be a key enabler in UK decarbonisation via:

- Strong, lightweight steels for transport (e.g. aerospace & automotive) for less use-phase $CO_2$.
- Next-generation electrical steels for future electrification.
- Traceable 'smart steel' for steel servitisation and asset monitoring e.g. in our rail network.
- Late-stage product definition from rationalised chemistries via advanced coating and thermo-mechanical processing allowing re-use, re-manufacture and multi-cycling.
- Transforming the construction sector by developing manufactured buildings for homes, public buildings, warehouses and care homes that generate, store and release energy.
- Steel for energy transformation in wind, solar, hydrogen transport and fusion reactors.

### 8.1.4.3. Established UK Research Base

The Clean Steel Innovation Fund will be able to make use of a well-established and world-leading research base here in the UK. The UK has strength and competitive advantage in steel-based R&D across the technology readiness levels, from university research through upscaling and implementation. There are two large critical mass R&I activities targeted at steel, SUSTAIN and PRISM. These act as conduits for the industry to engage with a large number of other complimentary activities investigating specific technologies or cross cutting challenges common to multiple industrial sectors.

### 8.1.4.4. Building to Net Zero

Drawing on this existing research base and resources allocated by the clean steel research fund will accelerate technologies from universities and pump prime regionally distributed innovation engines and industrial laboratories close to the major UK manufacturing assets. The fund will support the talent growth and skills escalation required for technological forward momentum and transformation in the agility and capability of the work force. Government funding enables Universities and Research Institutes to maintain and enhance the expertise critical to supporting the transition matched through recruitment and collocation of industry researchers. The combined strengths of these centres of excellence and the broader university ecosystem, through collaborative working, will enable the UK to become a world leader in addressing the net zero challenge. Specifically, the funds will support industry / academia exchange and collocation, acceleration of scale-up of crucial technologies and the development of an industrial doctorate scheme and training academy that will ensure the future pipeline of skills required to deliver these technologies and the Net Zero steel industry in advance of 2050. Previous such schemes, such as that run at Swansea have trained over 200 people 10% of which now hold director level positions in their businesses. Collectively, this will enable UK companies to increase market share at home and overseas.

**Recommendation:** Introduce a new Clean Steel Innovation Fund.

As we increase the availability of low-cost renewable power the opportunities for steel to become the material of choice for Net Zero manufactured goods are tremendous. Without carbon embodiment in its first use, and recognising that it can be multicycled through technical and scientific endeavour, steel produced today will be in use in different forms for centuries ahead.

## 8.2. Low-Carbon Steel Market

Regardless of what route and targets the sector and Government pursue in partnership, a low-carbon steel market will be needed. Decarbonising steel production relies on passing on the additional cost of decarbonisation to steel customers without being outcompeted by high-carbon emission steel imported from abroad. Table 1 shows the potential combination of policies to create such a market where producers can sell their low-carbon steel.

**Table 1 – Creating a low carbon market through border mechanisms or product standards**

| OPTION A | OPTION B |
|---|---|
| Carbon Border Adjustment Mechanism | Product standards |
| *Optional:*<br>Green public procurement<br>Carbon Tax | *Optional:*<br>Green public procurement<br>Carbon Tax |

The cost of producing steel will increase when carbon prices and overall climate mitigation costs increase. This is problematic for the steel industry since it competes in international markets. Any additional cost from reducing emissions cannot be passed on to consumers, as they will instead be outcompeted by foreign producers with lower prices. Therefore, the differences in production cost will lead to a substitution of steel from the UK with steel produced elsewhere. In a very narrow sense, this process will lead to a fall in domestic territorial emissions, as production shift abroad to countries which have not taken comparable climate action[36]. This is known as carbon leakage, which will likely lead to an overall global increase in emissions when consumption-based emissions are considered. It also impacts investment, as the investment will be directed towards countries where steel production offers the highest return on capital, resulting in substituted steel production that emits more carbon than allowed by UK climate policies. The UK imports about 2Mt of steel (31% of imports) from countries which do not face comparable carbon costs and exports 0.67Mt (20% of its export) to markets without similar carbon pricing in 2019[37]. Carbon Border Adjustment Mechanism, Product Standards, and Green Public Procurement aim to facilitate emission reductions while the climate change policies do not lead to "displacement of production and higher overall emissions"[38]. The principal aim will be environmental, as increased displacements would lead to higher global emissions.

Even when the industry in the future is decarbonised, it is still at risk of carbon leakage. This is also the case when carbon pricing increases and emissions intensity is decreasing, since the carbon costs are essentially swapped for increased operational costs (see below). The Net Zero compatible steel production methods all have higher OPEX than current production means, as such carbon leakage is still a big risk unless a low carbon steel market is created.

Some of these policy recommendations will be competing or have similar aims. For example, the Government's CCUS Business Models aim to cover the additional OPEX of deploying CCUS, thereby enabling competition with international manufacturers that do not face similar carbon costs and regulations. However, currently, it is being proposed that the CCUS contracts end after 10-15 years, at which point the companies would be fully exposed to the additional costs of CCUS, as detailed below. At this point, policies such as Carbon Border Adjustment Mechanism or Product standards would be absolutely essential. There is, therefore, an overlap between several policies and an uncertainty about how to transition between them, which illustrates the need for more work to be done with the Government to ensure the suitable compensation and carbon leakage protection.

### 8.2.1. Carbon Border Adjustment Mechanism

Carbon Border Adjustment Mechanism (CBAM) seek to "level the playing field among competing producers, and to create political leverage for more ambitious climate action across countries"[39]. CBAM would usually take the form of a tariff or other fiscal measure to imported goods from countries with lower or no climate change ambitions. It can be accompanied by export measures to compensate for domestic carbon constraint through tax or regulatory relief to enable selling in international markets.

The steel sector is an ideal market for CBAM, as it is at risk of carbon leakage and trade intensive. All steel products sold in the UK should face a similar carbon price, regardless of whether produced in the UK or imported from third countries. CBAM should be extended to all third countries without comparable carbon pricing to be effective and should be based on its place of manufacture so that steel produced in states without carbon pricing is not subsequently exported via to a country with carbon pricing to avoid the CBAM. This becomes especially important as the Government is consulting to reduce the industrial cap within the UK Emission Trading Scheme and thereby Free Allocations, which would substantially increase the carbon cost exposure. Similarly, although a CBAM can be implemented on certain steel products rather than all, consideration also needs to be extended to the effect on value chains. If not, then non-UK steel producers could shift to the production of semi-finished goods, bypassing the CBAM and losing valuable UK production[40]. CBAM will facilitate carbon reduction in the UK and have an overall environmental aim, in compliance with WTO rules, rather than just protecting UK steel from external competition.

#### 8.2.1.1. Options for delivery

There are many options for designing a CBAM for steel and other sectors at risk of carbon leakage. The EU, which has been working on its own CBAM, considered four options:

- **UK ETS:** Require importers to buy UK ETS allowances alongside domestic producers.
- **Carbon tariff:** Fixed carbon tariff on products from countries without comparable climate policy at the level of internal tax.
- **Carbon added tax:** A tax applied upon import and on transactions, applying a tax on the carbon content of products at each level of the supply chain with deduction of the tax paid upstream.
- **Consumption tax:** A separate tariff on imports and domestic products.

The EU has now chosen an equivalent to the UK ETS option, where imported products have to purchase Carbon Border Adjustment Mechanism (CBAM) certificates, which are linked in price to the EU ETS. As imported products to not need to buy EUA, the EUA price will not be impacted by the EU CBAM.

The border mechanism should be used as long as high-emission, lower-cost steel is widespread in the global steel market. It could initially be applied to only a few sectors, with other sectors opting in gradually, and apply to finished and semi-finished steel products. The UK could adopt an equivalence agreement with third countries that have similar carbon costs policies. The CBAM itself should also be implemented gradually over several years to ensure both importers and exporters are prepared.

Once the UK steel sector is fully decarbonised, the CBAM could become more challenging to implement, as the sector would not face any carbon costs. At this point, other policies can be considered, such as product standards, which prohibits imported high-emission steel from being sold in the UK market, presuming the majority of key steel-supplying countries have not decarbonised at this point.

Carbon Border Adjustment Mechanisms are a complex policy tool (like, for instance, the UK Emission Trading Scheme), and considerations need to be made in designing to avoid unintended consequences. In particular, any CBAM should be applied to steel in goods as well as semi-finished products. This would need to be supplemented with a robust and standardised measurement and verification mechanism. However, it also offers the possibility of protecting against carbon leakage, where the UK industry could slowly decline, and high-emission steel would be imported. It would allow UK steelmakers to operate with a higher OPEX without the need for ongoing Government support. As the UK and EU steel markets are so integrated, a UK CBAM will need to be align with the EU CBAM to avoid creating unnecessary trade barriers. The planned implementation of the EU CBAM creates an urgency to implement a UK equivalent, which will be implemented alongside the EU policy between 2023-2026. There is a considerable risk that without a UK CBAM policy, the UK could be flooded with high-carbon steel prevented from accessing the EU market. The UK Government has now committed to consulting on a UK CBAM later in 2022. It is imperative this this is done without delay and is implemented in tandem with any modifications to free allowance allocations being proposed.

**Recommendation:** Develop a UK Carbon Border Adjustment Mechanism for trade-exposed, carbon-intensive sectors, such as steel, and implement it with a gradual introduction by 2026.

### 8.2.2. Product standards

Product standards could be used to set clear market standards for how much carbon can be emitted in the production of steel products sold in the UK market. It would oblige producers, importing goods into the UK market, to comply with the required minimum standard[41]. Challenges include how to take account of imported steel that have already face carbon prices. Certifying all steel used throughout the supply chain may also prove difficult, as specific sectors have highly complex supply chains. For example, the auto industry has already established "sector-specific standardisation requirements and impose compliance certification, even on small and medium-sized suppliers"[42], and such additional certification may prove difficult.

As a policy tool, product standards for steel are perhaps more appropriate to implement once low-emission steel production is already established within the UK. At that point, it would be easier to set a new standard for steel products consumed in the UK, as the products already exist. Products standards for low-emission steel could be set some years in advance to allow the industry to transform its production in time for implementation, but, similar to CBAM, they do not offer assistance with the lack of available capital and do not address how companies can compete in non-UK markets with no standards. It would also assume that the UK would be a sufficiently large steel market to in itself be an incentive to transform production. It would also exclude the imports of any specialist steel products that the UK did not produce itself or limit imports to countries that have also decarbonised their steel sectors. This is why it is important that the UK engages proactively with key trade partners to also implement similar standards and create larger scales of market.

Like CBAM, product standards also suffer some of the same limitations, which include, but are not limited to:

- Whether to assess imported steel based on country of origin or production method
- How to handle imports of high-emission steel via countries with low-carbon steel production
- Embedded high-emission steel within personal vehicles or domestic appliances
- Source shifting, where the low-emission steel is sold to the UK, and high-emission is still consumed domestically.

Creating a low carbon steel market will be complex and take years to design. However, it will be essential to ensure the continuation of manufacturing in the UK and ensure that the UK does not offshore its production, its emissions, jobs, wider economic benefits, and general responsibility for the products it consumes.

Therefore, it would perhaps be beneficial to implement softer policy levers such as product labelling ahead of any product standards being implemented. Product labelling would increase transparency and experience with data collection, which would underline both formal product standards and Carbon Border Adjustment Mechanism but noting that they can be complex and take time to develop. Some customers are willing to pay a smaller premium for lower carbon steel; however, investment requires far greater certainty than soft levers can provide. No steel companies can invest billions on the basis that a few customers may look to purchase more green steel in the future. Developing product labelling or standards will rely on defining and developing a standard for assessing ‘green’, ‘clean’, or ‘sustainable’ steel. A common standard must be found and can be complex to develop, and thus it is recommended that Government and industry in partnership develop assessments methods for defining the impact of steel products.

As with the CBAM, the introduction of an EU CBAM increases the necessity of introducing a similar policy in the UK. Should the Government choose to proceed with product standards, they will need to be implemented by 2026 to avoid significant negative impact on the UK domestic market. Considerations will also need to be given to how product standards align with EU or US CBAM policies.

**Recommendation:** Develop product standards for the steel sector and a timeline for their gradual introduction by 2026.

**8.2.3. Green public procurements**

The UK Government is the largest single purchaser and consumer of steel in the UK, with the most recently published ‘steel pipeline’ from BEIS indicating 3.7Mt of steel to be required on infrastructure projects concentrated over the next five years. Purchases from devolved administrations and local authorities increase this figure further, estimated at over 1Mt a year in total and representing as much as 10% of the UK’s total steel demand. As such a significant consumer of steel, the public sector – led by the UK Government – has a hugely powerful policy tool at its disposal to start creating a market for low-carbon steel in the UK both through its own purchases and through influencing behaviour in the private sector.

The UK Government has published specific guidance on the public procurement of steel[45] which details how the public sector can design major projects in a manner that delivers best value for public money by taking into account the broader social and environmental impacts of their purchasing decisions. The guidance, first published in 2015, provides a valuable starting point. While it does refer to considerations such as sustainable sourcing, life-cycle costs, and energy management, it is arguably not explicit or prescriptive enough to achieve environmental objectives, including reductions in GHG emissions.  The same holds true of the Government’s Balanced Score Card guidance which includes environmental sustainability as a strategic objective but does leave consideration of environmental factors at the discretion of each project and focuses almost exclusively on post-contract/project considerations.

The following measures could strengthen the guidance on steel procurement to deliver better against climate change objectives and improve the Government’s ability to use its purchasing power to reduce emissions:

- Explicitly require all suppliers of steel to public projects to provide the origin of their steel. Knowing where steel has been produced is the most basic step in understanding its environmental impacts
- Require a balanced scorecard approach to be taken to the purchase of steel in major projects. This scorecard approach should take account of the emissions related to the production and transportation of steel used in projects
- Further steps could include discounting the costs of steel supply to take account of emissions
- Extending the guidance on steel procurement to energy projects receiving support through Government schemes – these are some of the most steel-intensive projects in receipt of Government support.

In addition, procurement alliances could be established with other governments or private sector buyers, increasing the market signal. 'For example, the Industrial Deep Decarbonisation Initiative, which the UK is co-leading with India as part of the Clean Energy Ministerial. There would be additional benefits of an internationally agreed definition for a standard environmental reporting mechanism for Green Public procurement, a standard evaluation process and tools for project bids, harmonized minimum standards, joint targets, certification services, and publicly accessible tools.

Green Public Procurement will pull the market towards lower carbon production, but there are limitations to how quickly existing steelmakers can transition to Net Zero production.

As such, it would be sensible to introduce Green Public Procurement policies from 2030, but before then, to strengthen existing procurement policies as outlined above.

**Recommendation:** Develop clear and robust public procurement guidelines, which gradually increases requirements for low-emission steel from 2030.

### 8.2.4. Carbon Pricing

Carbon pricing is a cost applied to the emission of carbon to the atmosphere as a discouragement to emit greenhouse gases (GHG)[44]. Carbon pricing aims to correct the market failure of climate change, where the external costs of carbon emissions are not internalised within the market prices.

The UK has already implemented several carbon pricing policies in the form of the UK Emission Trading Scheme, the Carbon Price Support (a levy placed on fossil fuel electricity generation), and the Climate Change Levy, amongst others. To avoid carbon leakage, steel producers receive free allocations under the UK ETS, compensation for the CPS, and are largely exempt from the CCL. However, the Government is currently consulting on reducing the UK ETS industrial cap, which would lead to a reduction in free allocations. Such a reduction in carbon leakage protection would increase the carbon cost for steel producers and impact their ability to compete with producers facing little or no carbon costs. Such reforms increase the need for urgent introduction of alternative carbon leakage protections, like CBAM or Product Standards.

The costs of carbon must be fed through to the steel consumer. As with the decarbonisation of the electricity supply, it is effectively the only way a business case can be built for low-carbon production in a free market where high-carbon forms of production are still present.

The main challenge of carbon pricing is its impact on competitiveness. As outlined in section 7.3, steel is a highly trade-exposed product and producers cannot pass on unilateral costs to their customers without losing market share. HM Treasury has previously assessed that the steel sector is one of the sectors most exposed to carbon pricing and at risk of carbon leakage, having one of the highest trade openness at 72%, combined with the highest carbon intensity (CO2 tonne/$m), and the third-highest proportion of CO2 from domestic sources.[47] The report showed that the steel sector's gross output was the most reactive to high carbon pricing amongst all sectors. Certain steel products are a commodity, which means they are priced globally, and suppliers are price takers. This can mean that steel suppliers often operate on thin profit margins, with difficulty passing through costs onto end users. The UK steel sector is thus affected by international different carbon costs. As there are currently no protections (such as carbon border adjustments or carbon product standards) from foreign steel producers exporting high-carbon, low-price steel into the UK and European market, carbon costs damage the industry's competitiveness.

If the domestic steel industry must compete with imported goods that are not subject to equivalent carbon taxes, it will be undercut. It must absorb the costs (of carbon or decarbonisation investment) itself, not passing them on to the consumer and therefore continuing a trend where there is no real business case for decarbonisation and domestic industry is increasingly uncompetitive. There is currently no market for "low-carbon steel", and it is not a criterion that a majority of customers primarily buy on the basis of, and therefore the role of carbon pricing or regulation must be to create one. Although often favoured as a straightforward policy tool to aid the reduction of GHG emissions, high carbon price on its own would not stimulate a shift toward decarbonised steel production in the UK without other supportive policies or measures to also apply the same carbon price to imported steel (including that contained in products), as they do not take into account the impact of different pricing levels globally and carbon leakage. Without uniform global carbon prices, additional policies need to be introduced alongside the UK ETS and other carbon pricing policies to ensure the steel industry will not be outcompeted by imported high-emission, lower-priced steel.

The alternative is to revise the UK ETS to reward decarbonisation. The UK ETS could allow businesses reducing emissions to retain their full free allowances as a result of $CO_2$ reduction measures if moving between product benchmarks but still producing the same output product. A third party should verify the reductions as annual $CO_2$ emissions and other elements of the UK ETS currently are.

**Recommendations:** Implement other policies alongside UK ETS to protect against carbon leakage or retain current protections such as free allocations and CCL exemptions.

## 8.3. Decarbonising by 2035

If the Government aims to significantly reduce the majority of emissions from the steel sector by 2035, then there are two main routes available: electrification and carbon capture, utilisation, and storage. Both courses will require the introduction of new policies and offer the Government a choice of direction.

### 8.3.1. Electrification

**Summary**
Electrifying UK steel production and switching to scrap-based production could be delivered within 5-10 years. Switching production methods would reduce emissions by over 80%, with emissions continuing to drop as the grid continues to decarbonise. To deliver this, UK Steel recommends:

- Lower industrial electricity prices
- Improved scrap quality
- Support for decarbonising heat
- Support for hydrogen and CCUS infrastructure at 'Dispersed' sites
- R&D funding

The scrap-based steelmaking process melts recycled steel in an electric arc furnace by heating the metal via an electric arc that is struck between the bottom of the electrode and the scrap. The UK already has four EAF plants, one in Cardiff, one in Rotherham, and two in Sheffield.

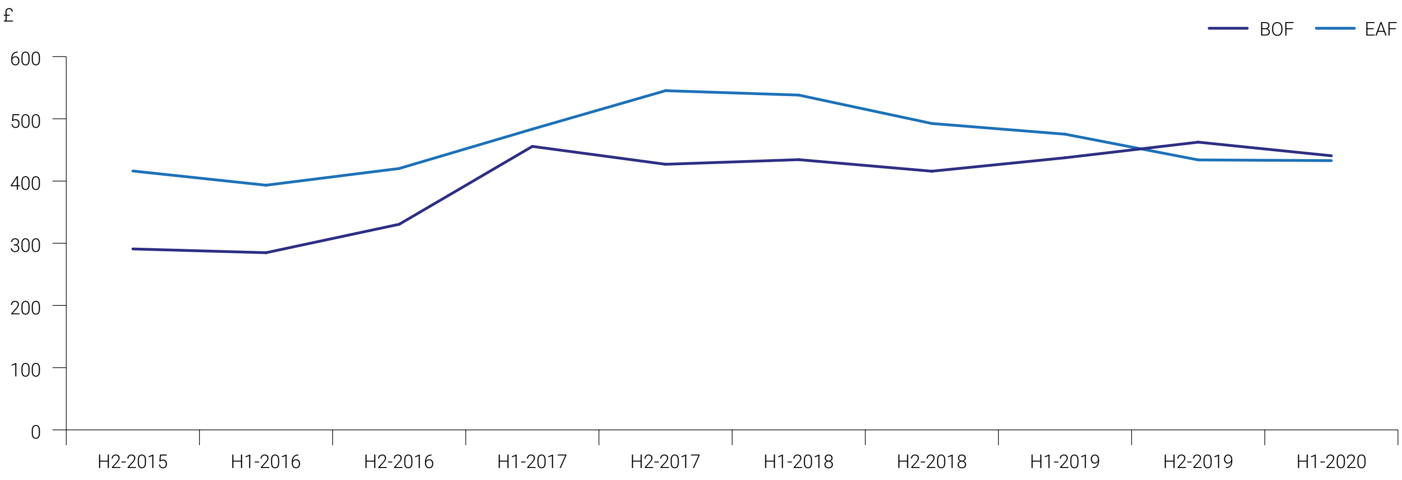
#### 8.3.1.1. CAPEX and OPEX

The CAPEX of an electric arc furnace varies depending on size, but a likely CAPEX would be closer to £400m for a plant with 1Mt capacity for existing ore-based sites. If the current 9Mt of ore-based production capacity were replaced by scrap-based production and electrified, the required CAPEX would be around £3.6bn.

Ore-based and scrap-based production routes are broadly comparable in terms of OPEX (i.e., costs per tonne of steel) for basic steel grades, although fluctuations in ore, coal, and scrap prices (broadly set at a global or regional level) will make one production route more cost-effective than the other at any one time. For example, for most of the last five years globally, the ore-based production route has been more cost-competitive than the scrap-based route due to lower coal and ore prices compared with scrap prices. If this cost advantage is maintained over significant periods of time, it naturally reduces the attractiveness of moving from BOF to EAF production (again placing to one side the barriers to doing so). However, this balance depends on global market developments and is unlikely to be influenced by UK specific policy.

Unlike blast furnaces, EAFs have more operational flexibility and can more easily reduce or shut down production without damaging the plant equipment. Because of the equipment's high capital costs, blast furnaces are much bigger to achieve economies of scale and aim for continuous operation. This provides an additional advantage to the EAFs in terms of energy management, their ability to shift demand from peak to off-peak hours, and to engage in demand-side response (DSR), which could reduce operational costs.

**Figure 23 – Global Production Costs of Ore-based (BOF) and Scrap-based (EAF) production**



*Source: UK Steel*

#### 8.3.1.2. Energy use

Converting the current ore-based production to EAFs would naturally lead to higher electricity consumption, as BOF plants moved from a reliance on predominately coal to grid electricity. As EAFs have a much higher grid electricity consumption, any move towards higher EAF production rates is not commercially viable due to the UK's high industrial electricity prices relative to other countries, which act as a major barrier to the electrification of steelmaking. Although some scrap-based UK producers operate within these sub-optimal conditions, the price disparity impacts the ability to attract investment into the UK. It is worth acknowledging that attracting investment for new EAFs are affected by several factors such as employment costs, taxation, social costs, and many others, but full decarbonisation requires additional EAF capacity where uncompetitive electricity prices are listed as the main barrier.

Overall, scrap-based steelmaking uses less energy than the ore-based route, with blast furnaces using 3.68MWh per tonne of liquid steel and electric arc furnaces using 0.67MWh per tonne of liquid steel[46], as scrap-based production does not need first to reduce the iron. But this should be seen in the broader context of basic steelmaking. To make steel from raw materials, the iron ore must first be reduced, which requires energy (whether via coking coal, natural gas, or hydrogen). This is in addition to the heat needed for melting and refining. The EAF process re-melts steel scrap that has already been manufactured once and therefore only must supply the energy associated with melting. The energy for the primary reduction of ore has already been provided when the steel was first made, which naturally leads to lower energy consumption for the EAF route.

#### 8.3.1.3. Indirect emissions

Currently, roughly half of the emissions related to scrap-based steel production occur through electricity consumption, but these have been continuously dropping over the past decade as the carbon intensity of the UK grid decreases. The Committee on Climate Change's carbon intensity target for 2030 is 50g $CO_2$e/kWh, which would represent an almost 90% reduction compared to 2009. As the grid further decarbonises, emissions related to power use will eventually be reduced to near-zero.

#### 8.3.1.4. Electrowinning

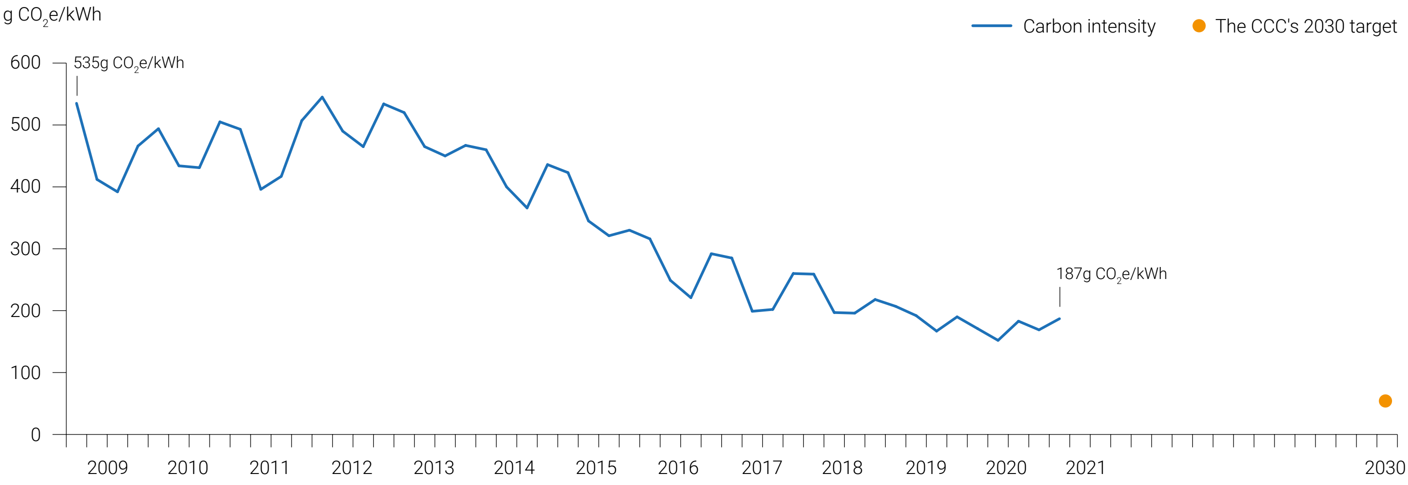
New production routes are being developed where electricity is used as the reducing agent in the electrolysis of iron ore called *electrowinning*. This process is still at an early stage of development and has only been tried at a lab scale[47]. However, fully converting steel production to electrowinning would require significant amounts of electricity. Estimates suggest that electrowinning would require 2.6-3.7MWh/tonne of liquid steel (tls), compared to 3.4MWh/tls for hydrogen-based production or 0.67MWh/tls for scrap-based production[48].

#### 8.3.1.5. Technical challenges and limitations

Although there are many opportunities to improve electric arc furnaces and achieve further energy efficiencies, the technical challenges are not comparable to CCUS and hydrogen-based steelmaking, since the technology has existed for over a hundred years and is widely used today. There could be site limitations in terms of sufficient grid capacity and were the whole sector to electrify, then an additional 3.8TWh would be needed, which would double the industry's electricity consumption.

However, there are other areas where there are opportunities for improvements. This includes the technology, which sorts and assesses the steel scrap into different grades. The techniques are currently not sufficiently advanced and often leads to poor quality scrap being delivered to steelmakers with various impurities (such as copper). New methods should be developed to increase control of the scrap resource and reduce residual

**Figure 24 – Carbon intensity of the GB electricity grid, 2009-2021**



*Source: Electric Insights*

elements, especially for steel grades which require low residual elements. Furthermore, direct support for R&D for EAFs would also help improve how steel can be recycled and increase the quality of scrap-based steelmaking. This could solve the current issue of certain steel products not being able to be produced through the scrap-based route.

#### 8.3.1.6. Timelines

Since EAFs are commercially available technologies, there are no technical limitations to their deployment, and therefore the timelines for advancing scrap-based are purely based on securing a viable business environment for further investment. Should this be provided, new EAF capacity could be deployed within 5-10 years, and the steel sector's emissions could be significantly reduced much sooner than 2035. The outstanding emissions would relate to heating and some remaining indirect emissions from electricity consumption. However, the specific timings would depend on the economic lifetime of the current assets, the cost-effectiveness of transitioning, availability of higher quality scrap, and other site-specific factors.

### 8.3.2. Policy changes required for electrification

Policy changes are necessary to reduce the remaining emissions from scrap-based production and enable a shift to the electrification of ore-based steelmaking.

#### 8.3.2.1. Lower industrial electricity prices

The key barrier to establishing further scrap-based production in the UK and improving the business environment for the existing producers is uncompetitive electricity prices. The proposals mentioned in section 6.1.1 under short-term measures will also deliver the parity of industrial electricity prices, which are needed to enable long-term decarbonisation through electrification.

**Recommendation:** Deliver parity of electricity prices via the proposed approaches in 2022.

#### 8.3.2.2. Improved scrap quality

Similarly, increased utilisation and improved quality of scrap are required to expand scrap-based steel production significantly. The policy recommendations listed in section 6.1.3 will deliver on this and create a path for a substantial increase in scrap use.

**Recommendation:** Implement new measures to increased utilisation of scrap.

#### 8.3.2.3. Support for decarbonising heat

Up to half of EAF-based steel producer emissions arise from heating via natural gas in the rolling and reheating of steel. Reducing these emissions will involve fuel switching from natural gas to hydrogen, syngas, biogas, or electricity, and waste heat recovery technologies in the short term. Waste heat recovery could now be supported through the Industrial Energy Transformation Fund and will improve overall efficiency. However, fuel switching relies on a readily available supply of alternative fuels and will require large scale production. As the sector currently uses 4.36TWh of natural gas (equivalent to the average annual use of over 400,000 UK households), the switch will require substantial quantities. The most likely substitution would be hydrogen, but not only is the infrastructure to deliver it unlikely to be available in the medium term, but it is also currently significantly more expensive than natural gas.

#### 8.3.2.4. Support for low-carbon fuel infrastructure at 'Dispersed' sites

Separate policies must ensure competitively priced hydrogen and the needed infrastructure to deliver the gas to industrial sites. BEIS is currently developing policies to support hydrogen production, but it is in its infancy and focuses on industrial clusters. Currently hydrogen will be available in industrial clusters by 2035, but not available nationally until 2040-2050[49], which risks isolating dispersed sites like the Outokumpu, Liberty Steel and Forgemasters sites. This could cause regional competitive distortions, if some sites have access to hydrogen to reheat steel in 2035, but others will have to wait until 2040. The ability to produce Net Zero steel would thereby rely on the extra costs of offsetting for those who cannot access hydrogen. For existing scrap-based producers at dispersed sites, decarbonisation will be unnecessarily delayed due to the current rollout rate of hydrogen infrastructure. Steel production sites can act as anchors for local demand for hydrogen even when not located in industrial clusters. Finally, support will be needed for investment in 'hydrogen ready' equipment.

**Recommendation:** Deliver competitively priced supply of low-carbon fuel and the infrastructure to deliver it at clustered and dispersed sites from 2025 – 2030 onwards.

#### 8.3.2.5. R&D funding

As outlined above, a Clean Steel Innovation Fund would be essential to enable the electrification of steelmaking in the UK.

**Recommendation:** Create a Clean Steel Innovation Fund to support R&D for the steel sector, consulting in 2022 and opening for applications in 2023.

### 8.3.3. Carbon Capture, Utilisation, and Storage

**Summary**
Deployment of CCUS at ore-based production could be delivered within 10-15 years, depending on the development of critical infrastructure and is the only method of decarbonising ore-based production by 2035. Applying CCUS would reduce emissions by between 50-70%, with an opportunity for higher capture rates if novel furnaces were deployed. To deliver this, UK Steel recommends:

- Policies to ensure competitiveness
- Access to industrial CCUS infrastructure
- Support for decarbonising heat
- R&D funding
- Lower industrial electricity prices

The other route that would enable decarbonisation by 2035 would be Carbon Capture, Utilisation, and Storage (CCUS), which is the only option to reduce emissions from ore-based steelmaking rapidly. It can be applied to the current production method or new forms of ore-based steel production (see HIsarna steelmaking below). CCUS captures the $CO_2$ from the industrial process and transports it for storing underground in depleted gas and oil fields or deep saline aquifer formations. In the case of South Wales, with no storage immediately available off the coast, $CO_2$ shipping will be required. CCUS can capture 80-90% of ore-based steelmaking emissions and thus have an excellent decarbonisation potential. However, initial retrofitting of CCUS to the blast furnaces without any capture from the sinter plant and coking stoves would likely lead to a 50-70% capture rate. Maximising the capture rate would require a significant rebuilding of the blast furnaces (such as HIsarna or DRI) and include capture from the sinter plant and coking stoves, increasing the capital costs significantly.

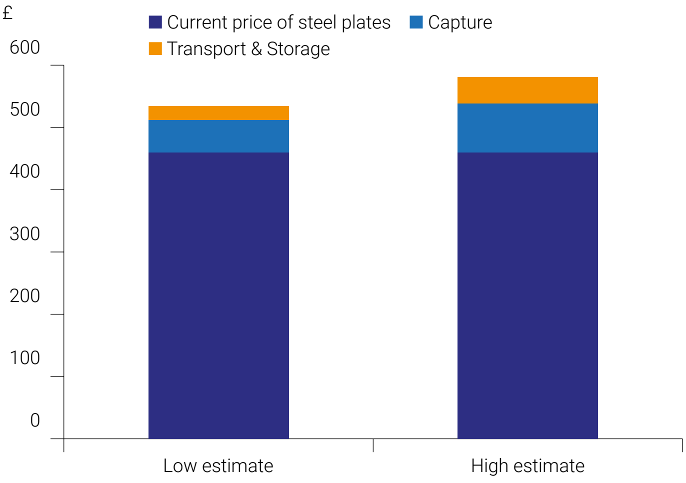
The next generation ore-based production methods are not commercially available. It is foreseen that the likes of HIsarna would be ready 5-10 years after it is proven on an industrial scale. With HIsarna in planning phase only and not yet built, it is not anticipated to be ready as a technology in line with the Climate Change Committee's 2035 target, underlining the need to apply CCUS to existing furnaces and sites to meet such ambitions.

It is worth emphasising that within a 2035-timeframe, CCUS is the only available technology to reduce emissions from ore-based production significantly. This will be especially true for the production of specific steel grades, which require ore-based production. As outlined above, ore-based production is essential to meeting global steel demand and will continue to be beyond 2050. To prevent significant climate change, the world has to solve the decarbonisation of ore-based steel production. There will be significant commercial opportunities from the associated intellectual properties with any decarbonised ore-based production – giving the UK a substantial advantage.

**HIsarna:**
By preheating coal and using partial pyrolysis, significantly less coal is needed leading initially to 20% fewer $CO_2$ emissions, with the option of increasing this to above 80% with CCUS. The HIsarna process removes the need to pre-process ores and metallurgical coal, which eliminates the production stage of making coking coal, sintering, and the pellet plants.

In 2018, HIsarna became part of the production chain in IJmuiden, in the Netherlands. The next stage is to design, build and test an industrial-scale pilot plant. This step is necessary in order to be able to commercialise the technology and to make steelmaking ever more sustainable. Tata Steel is considering building a second larger test plant in India. If testing on an industrial scale proves to be a success, it will be another five to ten years before the technology can be put on the market commercially.

**Figure 25 – Cost of steel with CCUS, £/tonne of steel**



*Source: UK Steel*

#### 8.3.3.1. CAPEX and OPEX

Industry estimates for capital expenditure for a CCUS retrofit plant (at 50-70% capture rate) are at £200m-250m per Mt of hot metal. If CCUS was applied to the current 9Mt of ore-based production capacity, the required CAPEX would be around £1.8bn-2.25bn

Estimates for cost per tonne of carbon captured vary depending on capture technologies and storage costs, but for retrofit of OPEX is estimated to be around £61-101/ $tCO_2e$, including transport and storage[50]. OPEX of £61-£101/ $tCO_2e$ would roughly lead to a 16%-26% increase in the cost of producing a finished steel product[51], depending on the product and overall efficiency of the steel plant. Since profit margins of 6% are used as a benchmark for long-term viability for steel companies within EU trade remedies investigations, it is evident that trying to accommodate a 16-26% increase in costs will not be possible without government intervention. There are multiple options for supporting CCUS, including the CCUS business models currently being developed by the Government, which for South Wales will need to take account of the need for $CO_2$ shipping. The other options involve creating a low-carbon steel market through various policies outlined earlier in the report.

Finally, it is also worth mentioning increased energy consumption related to CCUS operations at steel sites. Applying CCUS in coal power generation leads to an additional energy use of 15-28%[52]. A similar energy penalty applied to power plants of ore-based steelmaking sites would lead to a 10% increase in grid electricity and an additional OPEX cost of around £4m a year per site. Competitively prices electricity prices therefore also become very important to unlocking CCUS for the steel sector.

#### 8.3.3.2. Biomass CCUS

Currently, coal is used in ore-based steel production to reduce the oxygen content; however, it would also be possible to use biomass in the form of bio-coke as the reducing agent. In combination with CCUS, it would be possible to exceed the 80-90% reduction rate on current levels of $CO_2$. Together, these could operate in ‘carbon-negative’ mode, where steelmaking could effectively be taking $CO_2$ out of the atmosphere. No in-depth study of the costs of biomass steel production with CCUS has been conducted, so it is not possible to assess its capital costs or ongoing operational costs. Bioenergy Carbon Capture and Storage (BECCS) is vital to meeting the Net Zero target, and it is estimated to be of lower costs than other negative emission technologies such as direct air capture. Using bioenergy in steel production could become a vital method for the UK to achieve its negative emissions needed for future targets.

#### 8.3.3.3. Technical challenges and limitations

The lack of widespread deployment of CCUS at steel production sites is a key limitation, making feasibility, requirements, costs, and performance more difficult to assess[53]. In addition to the requirements for capital investment and increased operational costs, there are numerous unknown risks from increased operational complexity and plant integration; high levels of uncertainty regarding costs and budgeting; a general lack of staff familiarity and operating expertise; in addition to consideration for availability of space onsite for CCUS plant and any impact on the product quality. These barriers likely also apply to other technologies untested at a commercial scale, such as hydrogen, and are not isolated to CCUS. There will also be site-specific barriers to the deployment of CCUS, which limits its applicability at scale.

#### 8.3.3.4. Timelines

Deployment of CCUS is very dependent on broader infrastructure and cluster development, as it will require either CCUS pipelines or shipping facilities to receive the captured carbon. As CCUS is more developed as a technology than, for example, hydrogen-based steelmaking, deployment timelines would be shorter. As such, it would theoretically be possible to deploy CCUS (with the capture rates of 50-70%) within this decade, but higher capture rates would require a significant rebuild of blast furnaces and would push timelines into the early 2030s.

### 8.3.4. Policy changes required for CCUS

Policy changes are necessary to enable the deployment of carbon capture, utilisation, and storage. This route will require many industries to come together to deliver in addition to site-specific challenges. These are, therefore, the most immediate and necessary policies.

#### 8.3.4.1. Policy to ensure competitiveness

Deploying CCUS to steel plants will increase the cost of steel production. These costs must either be carried through to the end consumer in a low-carbon steel market or alternatively addressed through separate policies to ensure the competitiveness of the steel products. Separately, a CCUS plant will require significant capital expenditure, which is difficult to finance considering the market challenges outlined earlier in this report. As such, a key enabler of CCUS at steel sites will be additional policies that deliver a route to market, which could, for example, be the Industrial CCUS Business Models currently being developed by the Government. However, such policies would need to be negotiated bilaterally between relevant companies and the Government.

**Recommendation:** Develop a policy to ensure the competitiveness of steel production with CCUS by 2022, which will enable deployment during the 2020s.

### 8.3.4.2. Access to industrial CCUS infrastructure

Similarly crucial would be the CCUS infrastructure connected to steel sites, enabling the transportation of GHG emissions from the capture unit to the $CO_2$ storage. Currently, CCUS infrastructure is being supported through the Government's Industrial Cluster programme, supporting two CCUS clusters by 2025 and a further two by 2030. Unlike other industries, the steel sector is lucky to be placed in industrial clusters, facilitating the necessary CCUS connections. However, the timeline for the separate clusters is still unclear, as the final funding has yet to be allocated. This could be concerning if the relevant clusters were not provided with the needed support in time to enable the steel companies to deploy CCUS at their sites. If, for example, the cluster was not provided with funding for deployment by 2025 or 2030, it would jeopardise steel companies' ability to reach a 2035 decarbonisation target. Therefore, it is worth considering whether the current target of four industrial clusters by 2030 is sufficient to enable industrial decarbonisation at scale.

**Recommendation:** Support the development of industrial clusters and CCUS infrastructure near steel sites by 2030.

### 8.3.4.3. Support for decarbonising heat

A switch to CCUS will require low-carbon fuels for the rolling and heating of steel, which will involve infrastructure to deliver it and competitively priced low-carbon fuel.

**Recommendation:** Deliver competitively priced supply of low-carbon fuel and the infrastructure to deliver it at clustered and dispersed sites from 2025 – 2030 onwards.

### 8.3.4.4. Lower industrial electricity prices

Deployment of CCUS at steel sites will lead to an energy penalty, as described above, and steel sites will therefore increase their import of electricity from the grid. The proposals mentioned in section 6.1.1 under short-term measures will deliver the parity of industrial electricity prices, which are needed to enable decarbonisation through CCUS.

**Recommendation:** Deliver parity of electricity prices via the proposed approaches by 2022.

### 8.3.4.5. R&D funding

As outlined above, a Clean Steel Innovation Fund would be essential to enabling CCUS in the UK.

**Recommendation:** Create a Clean Steel Innovation Fund to support R&D for the steel sector, consulting in 2022 and opening for applications in 2023.

## 8.4. Decarbonising beyond 2035

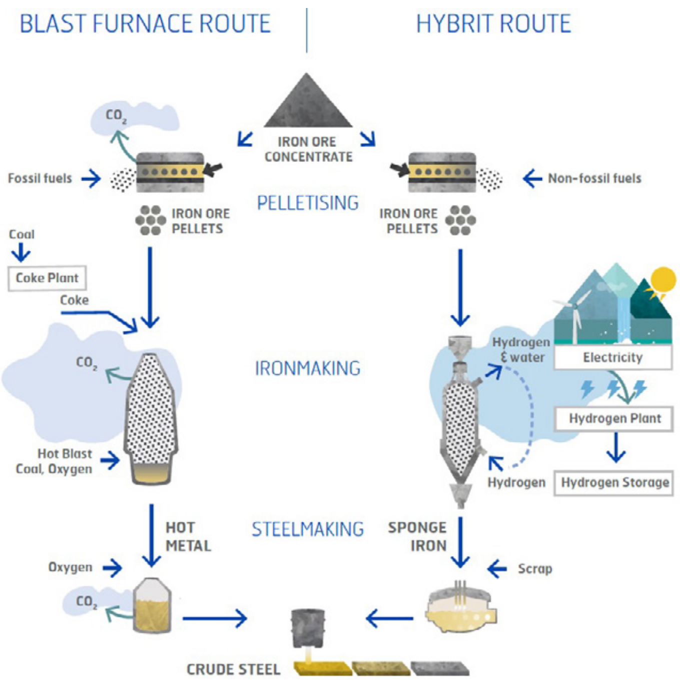
If the target of significantly reducing most emissions from the steel sector were pushed beyond 2035, an additional route would be available: hydrogen-based steelmaking. The potential novel process of producing steel would similarly require new policies and offer the Government an extra choice of direction.

**Summary**

Hydrogen-based steel production could be delivered by 2040, depending on the costs and availability of hydrogen, with an interim option of switching to DRI, reducing emissions by half. Hydrogen-based steelmaking would reduce emissions by over 90%. To deliver this, UK Steel recommends:

- Lower industrial electricity prices
- Policy to ensure competitiveness
- Low-carbon hydrogen
- R&D funding

**Figure 26 – Illustration of DRI hydrogen steelmaking**



*Source: SSAB, HYBRIT*

### 8.4.1. Hydrogen-based steel production

Hydrogen-based steelmaking is an emerging ore-based production method, essentially a low-carbon modification of a lesser-used, but established, steelmaking technique known as direct reduced iron (DRI). This novel form of DRI uses hydrogen gas as the reductant to reduce the oxygen in the iron ore, with water as a by-product. It produces an intermediate product, sponge iron or DRI, which can be melted in an electric arc furnace (EAF) together with recycled scrap[54]. Using hydrogen as the reductant in the DRI plant would lead to near-zero process emissions and the need for oxygen blowing eliminated or very much reduced[55], significantly reducing the CO$_2$ emissions.

8.4.1.1. CAPEX and OPEX

Hydrogen-based steel production has been performed in test labs, but not at a commercial scale. The first full demonstration plant is not expected to be ready until 2025, making CAPEX and OPEX estimates more uncertain. CAPEX estimates range from £500-750m/Mt of steel[56], but this estimate includes an electrolyser. Given the UK industrial electricity prices, it is unlikely that hydrogen would be produced through electrolysis, but rather through steam reforming of natural gas to convert methane to hydrogen and capturing and storing the carbon. Due to the lack of available data, a CAPEX estimate for a hydrogen-based DRI plant without an electrolyser is not available. However, as conventional DRI plants could be converted to hydrogen[57], perhaps a helpful comparison would be the Voestalpine DRI plant in Texas at a total cost of US$1.1bn with a capacity of 2Mt[58], but it will use natural gas rather than hydrogen. Additional costs would be expected later, as the plant converts to hydrogen.

Few OPEX estimates are available, but the HYBRIT project estimates a 20-30% increase in the cost of producing crude steel in Sweden, dependent on the prices of coking coal, electricity, and emission rights[59]. They do not provide any further detail on how they arrived at this estimate, as it is commercially sensitive. It is difficult to compare this to potential hydrogen-based steelmaking in the UK, as Swedish hydrogen would be produced with very low-cost hydropower, where British hydrogen would need to be created through steam reformation with CCUS. A UK OPEX would thus likely be higher. Estimates for hydrogen productions range around £50/MWh when through steam reforming, which is twice as expensive as natural gas, although it has been projected to decrease to £40/MWh in 2030 and £20/MWh in 2050, at which point it would be competitive with natural gas[60]. This still assumes some form of carbon prices (or equivalent measures) where emission reductions have a value since hydrogen must be manufactured, unlike natural gas, which must only be extracted and thus will likely always be cheaper.

### 8.4.1.2. Energy use

For ore-based steel production, more energy is required to reduce the iron, which has already been reduced in scrap-based steel production. A blast furnace consumes about 3.68MWh per tonne of steel, mainly in the form of coal and coke, compared to hydrogen-based steelmaking's energy consumption of 3.48MWh/t (excluding secondary metallurgy, pelletising, casting, and rolling)[61]. If using hydrogen from steam methane reforming, the sector would need up to 25TWh for the reduction process alone, plus an additional 3-4TWh for rolling and indirect heating[62]. However, if through electrolysis, the HYBRIT project estimates a 6-7X increase in electricity demand[63]. As the hydrogen use would be significant, a steel plant would be a substantial anchor for hydrogen use, which could support the development of a hydrogen production industry.

### 8.4.1.3. Technical challenges and limitations

There are several technical challenges, including risks associated with using a more combustible fuel; the lack of understanding of how hydrogen reacts in different environments; HSE familiarity; and NOx emissions when combusted[64]. It will likely require several proven trials to resolve some of these issues, and, thus, large pilots or small commercial size will be invaluable to progressing hydrogen-based steelmaking. It is not expected that any of these will be showstoppers, however, this is difficult to estimate as the production route is still in its infancy, with no demonstration plant yet fully commissioned.

Finally, there is presently no bulk hydrogen production at an affordable price in the UK nor the infrastructure to deliver the fuel to the site. Should the sector eventually switch to hydrogen produced through electrolysis, it would have significant implications for electricity demand and the additional capacity needed to generate 6-7x as much electricity for the sector.

### 8.4.1.4. Timeline

Several steel companies worldwide have experimented with including some hydrogen in their blast furnaces, but no company has a fully hydrogen-based steel production. A couple of fully hydrogen-based steel plants are under development, with the Swedish HYBRIT being the furthest. The HYBRIT project expects to have a demonstration plant ready in 2025, and a few other companies are hoping to have demonstrations plants ready in the late 2020s. However, a fully operational hydrogen-steel plant operating at a commercial scale is not expected until the mid-2030s. As the HYBRIT project started in 2016 and are only starting to scale up from the late 2020s to early 2030s to full commercial operations, it is unlikely that hydrogen-based steelmaking would operate commercially in the UK before the late-2030s or early 2040s. This would make hydrogen-based production incompatible with a Government decarbonisation target of 2035. However, it could be fully operationally by the late 2030s or early 2040s, well in advance of the 2050 Net Zero target, but this would be dependent on cost-competitive hydrogen.

**Table 2 – International hydrogen-based steel development**

| Country/Project Name | Date commercially operational |
|---|---|
| HYBRIT, SSAB, Sweden | 2025: Demonstration plant operational<br>2026: Gradual increase in production |
| Salcos, Salzgitter, Germany | 2026: Pilot phase, some hydrogen use in DRI ($30\% CO_2$ reduction)<br>2030s: Increased hydrogen use ($50\% CO_2$ reduction)<br>2050: Full conversion to hydrogen ($82\%-95\% CO_2$ reduction) |
| ArcelorMittal, Germany | Unclear timelines. 2030: hydrogen blending in two DRI plants, and overall company commitment of 30% $CO_2$ reduction by 2030. |
| ThyssenKrupp, Germany | 2025: Regular DRI plant; increased use of hydrogen, but unclear timelines for complete hydrogen conversion. |
| H2FUTURE, voestalpine, Austria | Unclear timelines. |
| Fortescue Metals, Australia | Unclear timelines and no clear plans for hydrogen-based steelmaking. |
| HBIS, China | 2021: DRI plant will start using some hydrogen-enriched gas<br>Unclear timelines for full hydrogen use. |

*Source: UK Steel*

It is worth emphasising that hydrogen-based steelmaking is technical feasible sooner than 2035, but not commercially feasible. Original Equipment Manufacturer (OEM) are starting to offer DRI, which can handle hydrogen later. However, the main barrier is access to cost-competitive hydrogen, which the industry does not expect to be available until after 2035 at the very earliest. Hydrogen may only become competitive towards 2050 unless substantially subsidised by the Government.

It would be possible to commission DRI natural gas-based steelmaking in the UK, followed by a switch to hydrogen when the technology will be proven commercially, as outlined in the Syndex/Materials Processing Institute report[65]. This would allow the UK sector to make investments over the next couple of years until hydrogen was widely available at competitive prices. A DRI plant using natural gas would likely see carbon reductions of over 50% compared to conventional coal-dependent BOF ore-based production. The DRI plant could also deploy CCUS at the site to reach over 80% emission reductions in the time until hydrogen was cost-competitive. However, DRI plants are currently not operating widely in the UK and the rest of Europe as it is dependent on the cost of natural gas, which is relatively more expensive in Europe than globally. The recent substantial increase of gas prices would have worsened the business case. This would make using natural gas-based DRI commercially unattractive, unless the Government intervened to support it.

### 8.4.2. Policy changes required for hydrogen-based steel production

Policy changes are necessary to develop hydrogen-based steelmaking in the UK. This route does carry some additional risks and would require different approaches to the other decarbonisation options. Examples include a consortium between the Government and steel companies, similar to the Swedish HYBRIT project, or a share facility (through a joint venture and co-funded by Government) selling hydrogen-based DRI to steel companies.

#### 8.4.2.1. Lower industrial electricity prices

With the sponge iron from the hydrogen plant being melted in an electric arc furnace, electricity will be a crucial component of hydrogen-based steelmaking and thus competitive industrial electricity prices. The existing projects in Germany and Sweden rely on competitive power prices, and the sector needs parity of prices to enable the same route in the UK.

**Recommendation:** Deliver parity of electricity prices via the proposed approaches by 2022.

#### 8.4.2.2. Policy to ensure competitiveness

Hydrogen-based production will carry higher operational expenditure than traditional steelmaking. These costs must either be carried through to the end consumer in a low-carbon steel market or alternatively address through separate policies to ensure the competitiveness of the steel products. Separately, a hydrogen-based steel plant will require significant capital expenditure, which will be difficult to finance considering the market challenges outlined earlier in this report. As such, a key enabler of hydrogen-based steel production will be additional policies that deliver a route to market. However, such policies would need to be negotiated bilaterally between relevant companies and the Government.

**Recommendation:** Develop a policy to ensure the competitiveness of hydrogen-based steel production by 2025.

#### 8.4.2.3. Low carbon hydrogen

A switch to hydrogen-based steel production will require infrastructure and competitively priced hydrogen. The two ore-based sites would need up to 25TWh for the reduction process, plus an additional 3-4TWh for rolling and indirect heating for the entire sector[66]. This is more than the UK's current hydrogen production of 27TWh of hydrogen production[67]. Vitally, this will need to be sufficiently low cost and at least match natural gas prices to encourage fuel switching. The upcoming Hydrogen Strategy is an opportunity to set out a realistic and ambitious vision for the growth of the hydrogen economy, which gives the certainty needed to incentivise investment. It should accelerate the pace of deployment of low carbon hydrogen to position the UK ahead of other European countries with more progressed strategies. Business models should incentivise early movers to transition from fossil fuels to hydrogen while allowing for operational capacity for blending of fuels to create resilience and reduce risks for users. Large-scale public funding will be needed to be put in place to enable infrastructure for the transition to low $CO_2$ steelmaking using hydrogen.

**Recommendation:** Deliver competitively priced hydrogen supply and the infrastructure to deliver it at clustered and dispersed sites from 2025 – 2030 onwards.

#### 8.4.2.4. R&D funding

As outlined above in section 8.1.4, a Clean Steel Innovation Fund would be essential to enabling hydrogen-based steelmaking in the UK.

**Recommendation:** Create a Clean Steel Innovation Fund to support R&D for the steel sector, consulting in 2022 and opening for applications in 2023.

## 8.5. Interdependence

This report has outlined three distinct routes for decarbonisation of the steel sector. However, the most likely route will inherently be a mixture of CCUS, electrification, and hydrogen. Rather than competing technologies, they will instead be complementary. Below are outlined several scenarios where the routes will be blended, and each will depend on the specific site, products, and infrastructure, amongst other factors:

- Hydrogen-based steel production will fundamentally be dependent on electrification, as the sponge iron produced in a DRI plant with hydrogen will need to be melted in an electric arc furnace. If the hydrogen is produced via electrolysis, the dependency will be even higher.
- The hydrogen-DRI sponge iron could also be produced abroad and imported, where it would be melted in EAFs.
- As hydrogen prices can be prohibitively costly and act as a barrier to DRI plants, it would be possible to commission DRI natural gas-based steelmaking in the UK until hydrogen prices fall. CCUS could be applied to the DRI plant to capture its emissions.
- Some hydrogen or biomass can also be added to existing blast furnaces in combination with CCUS to achieve higher

emission reduction. Hydrogen will also likely be needed for the downstream processes (e.g., rolling and heating of steel) at both scrap-based and ore-based sites.

- Finally, a site may choose to replace one blast furnace with an EAF and deploy CCUS to the remaining furnace to continue to produce some ore-based steel.

The actual process for significantly reducing emissions associated with steel production will thus be much more complex. Therefore, a broad package of policies will likely be necessary to assist the decarbonisation of the UK steel sector.

## 8.6. Jobs and Skills

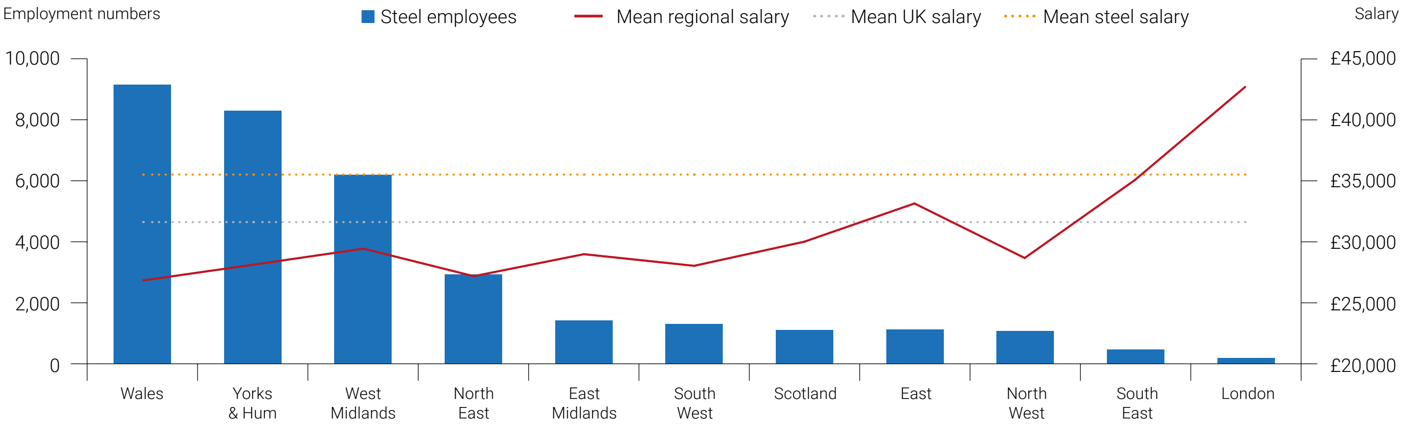
The UK steel sector currently employs over 32,000 people, principally in Yorkshire & Humberside, Wales, the North East, and the Midlands. The average wage of our workers is 18% higher than the UK average and 36% higher than the regional average in Wales and Yorkshire & Humberside. Higher paid workers naturally contribute disproportionately more to local economies and should be at the core of the Government's 'Levelling Up' policy. It underlines the opportunity to retain highly skilled jobs in less prosperous regions of the UK, which could otherwise be significantly impacted by the journey to a green economy.

The sector train hundreds of skilled individuals every year, with approximately 65% of the sector's technical workforce is educated to degree level and around 40% possess a postgraduate qualification. The programmes of support and training provide meaningful, well-paid jobs for young people entering the workforce without having to travel miles away from their hometowns.

A Net Zero steel sector will be comprised of transformed existing sites and potential new sites. Managing this transition will be crucial to maintaining existing jobs and transforming them into green jobs while minimising the risks of job losses. The vast majority can remain fundamentally unchanged, and a small number of new roles and skills sets will be required.

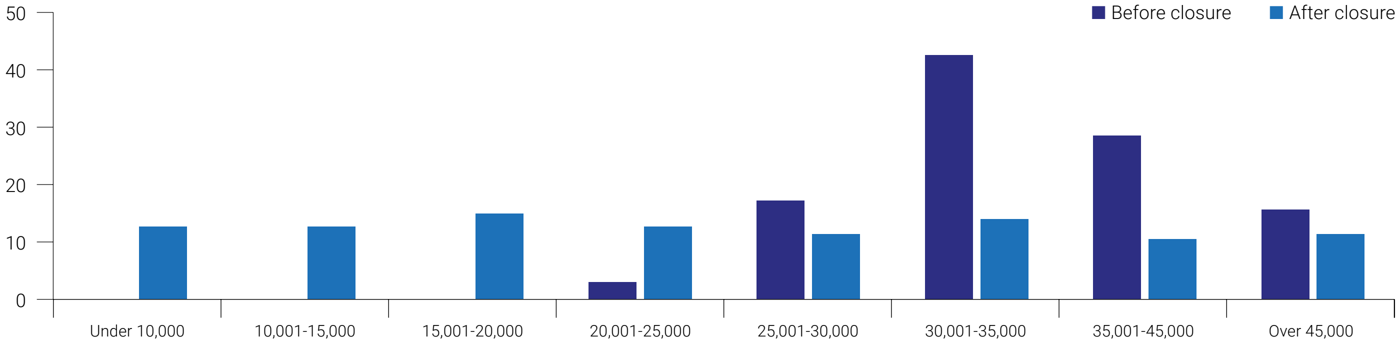
The transition is not without risks, as rapid technology transformation and increases in productivity could lead to job reductions if not well managed. The production of virgin steel through hydrogen-based production or via CCUS is more 'job intensive' per tonne of steel produced than scrap-based production via EAF, which must be taken into account when considering the route to Net Zero. However, if the Government provides the right framework for supporting all routes of decarbonisation, the steel companies can manage the transition. For example, as outlined above, sites may choose

**Figure 27 – UK steel sector employment by region, average steel sector wage and average UK wage**



*Source: ONS Business Register and Employment Survey, ONS Annual Survey of Hours and Earnings 2019*

**Figure 28 – Earnings before and after the closure of the Redcar plant (£ per year, % of workforce)[69]**



*Source: Community survey of former SSI workers*

to partly decarbonise through electrification and CCUS, where the reductions in jobs due to the EAF can be managed through natural retirement, investment in downstream production, and new CCUS opportunities.

The alternative to a well-managed process can be seen with the closure of Redcar steelworks in 2015, which had very large implications for the employees and local community. Analysis showed that although 80% had found work within a year of the closure, it was reported that 18% took up to two years to find new employment[68]. Where all of the research participants were working full time, only 64% found full-time work. As outlined above, steel wages are usually higher than the regional average, with 80% of respondents earning above £30,000 before the closure, only 35% did so in their new jobs, which is shown in figure 28.

The Net Zero target offers great opportunities to not only retain existing jobs, but transform them into green jobs for the future and avoid the misfortunes of the past. Unlike other industries, which perhaps are less needed in a Net Zero economy, such as oil refinery, where carbon-intensive jobs disappear and employees will need to find jobs in a different sector and aquire new skills, the steel industry offers the opportunity to save and transform carbon-intensive jobs into green, low-carbon jobs. In addition, new opportunies may also appear as the sector invests in CCUS, hydrogen-based DRI, and electricification. 'Green jobs' will not be confined to the renewable energy industry, but will be at the heart of steel production in the UK. Exciting opportunities for jobs and training in regions the Government wants to level up will be possible through a well-managed transition, where the industry becomes a natural part of the Net Zero economy of 2050.

The sector benefits from good industrial relations and a history of trade unions and companies working together to confront major challenges within the industry. Both are committed to decarbonising the steel industry through a fair process of transition that protects employment and recognises the importance of the industry to steel communities across the UK. The steel producers and the trade unions are committed to a continued dialogue on decarbonisation at a sectoral level, and the companies are committed to working with the trade unions at company level to deliver decarbonisation with the workforce in key areas, including jobs and skills.

Indeed, new skills will be needed when transitioning to Net Zero steel production, but this is less well researched, with some work taking place at Cardiff University. Where scrap-based production is well established, the onsite application of CCUS will require new engineers with specialised skills and knowledge of capture technology and transportation. Similarly, the increased use of hydrogen will necessitate process safety engineers to manage the added risk of hydrogen. As the steel companies' plans become clearer, as will the need for additional skills and training.

**Table 3 – Current UK demand, current UK sales, forecast UK demand and future UK opportunity by sector for finished steel**[71]

| | Tonnage | | | | Value | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Sector | 2015 Current demand (Kt) | 2030 Forecast demand (Kt) | 2015 Current UK sales (Kt) | 2030 Future opportunity (Kt)* | 2015 Current demand (£m) | 2030 Forecast demand (£m) | 2015 Value of current UK sales (£m) | 2030 Future opportunity (£m)** and breakdown (%) | |
| Construction | 5,554 | 6,879 | 2,539 | 4,340 | 2,003 | 3,352 | 880 | 2,170 | 57.3 |
| Others | 1,510 | 1,760 | 756 | 1,004 | 654 | 1,122 | 232 | 770 | 20.4 |
| Automotive | 711 | 645 | 285 | 360 | 348 | 471 | 120 | 293 | 7.7 |
| Machinery & Engineering | 538 | 611 | 304 | 307 | 226 | 349 | 116 | 194 | 5.1 |
| Packaging | 456 | 462 | 259 | 202 | 213 | 314 | 122 | 136 | 3.6 |
| Oil & Gas | 353 | 253 | 57 | 196 | 191 | 163 | 27 | 129 | 3.4 |
| Yellow Goods | 142 | 186 | 43 | 143 | 58 | 104 | 17 | 80 | 2.1 |
| Rails | 166 | 182 | 158 | 24 | 84 | 94 | 80 | 12 | 0.3 |
| **Total** | **9,430** | **10,977** | **4,400** | **6,577** | **3,775** | **5,969** | **1,594** | **3,785** | **100** |

*Notes: *2030 forecast demand minus 2015 current UK sales; **2030 forecast demand minus 2015 current UK sales, valued using 2030 prices*

## 8.7. Opportunity for growth

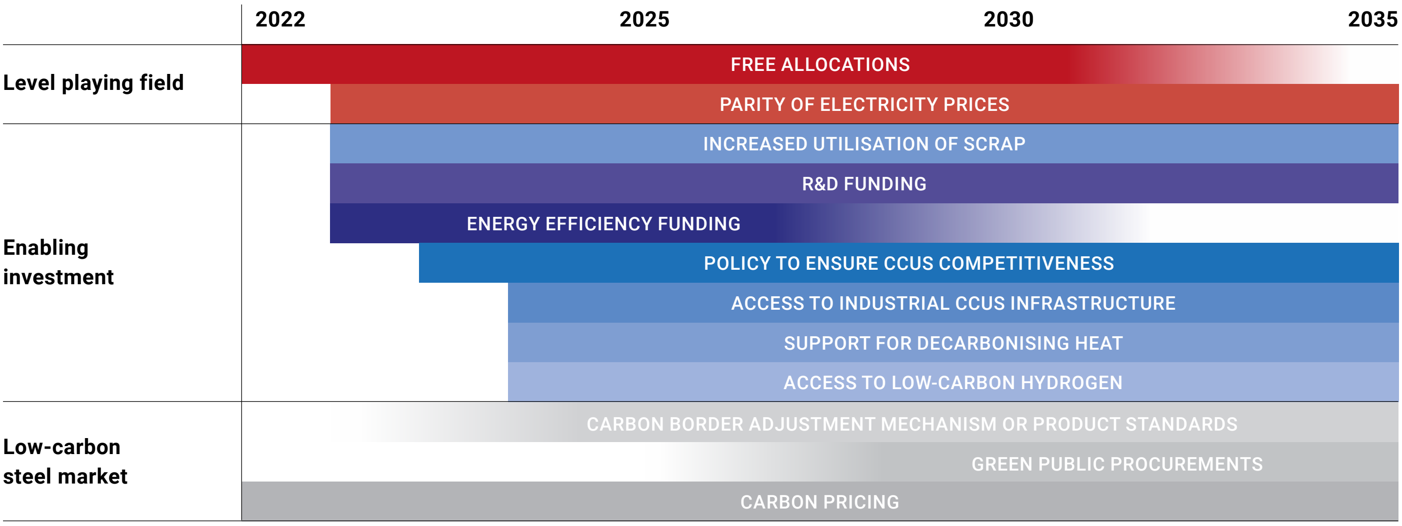
With the right framework for meeting Net Zero targets, the UK steel industry not only has an opportunity to be the first steel sector globally to decarbonise, but there are also tremendous growth opportunities. As outlined in the Government research paper, *Future Capacities and Capabilities of the UK Steel Industry*[70], the demand for finished steel is predicted to grow from 9.4Mt in 2015 to 11.0Mt in 2030. Several factors drive this, but primarily increasing investments in infrastructure construction. It represents a prospect of 6.6Mt to the domestic steel industry and an opportunity to displace current imports.

The report identifies the main areas of opportunities, which account for $^{2}/_{3}$ of the prospective growth areas: coated products and organically coated steels (£958m), stainless steel (£573m), HRC (£440m), rebar (£315m), and heavy sections (£279m). Overall, there is a future revenue opportunity worth *£3.8bn annually* in 2030 compared to the current domestic supply. Construction stands out at £2.2bn or 57% of the total opportunity, followed by automotive at £0.3bn (7%).

The authors also identify another growth opportunity in the gap between true steel demand (which includes steel embedded in imported products) and UK steelmakers current delivery to the home markets. True steel demand was 16.1Mt in 2015, but domestic supply was only 4.4Mt, leaving a gap of 11.7Mt, which could be filled by increased UK production. However, it is worth noting that to close this gap, additional barriers will need to be addressed, such as re-shoring manufacturing, and will require longer-term strategies and cross-sector collaboration[72].

Finally, there is also a chance to increase exports, as the UK exported less than other EU countries when the report was written. UK exports were 43% compared to Germany (57%), Italy (58%) and Spain (62%). This has now grown to 45%, but Net Zero represents a break to increase this further. As the sector aims to fundamentally change its production methods and become the first country to decarbonise its steel sector, there are great opportunities to grow production if the right framework is implemented. With a supportive policy framework and suitable market environment, the UK steel sector can invest in Net Zero production, drastically reduce carbon emissions, and grow its steel production through increased demand, exports, and closing the gap between current delivery and true steel demand.

Figure 29 – Potential sequence of policy intervention



*Source: UK Steel*

## 8.8. Timeline for intervention

The sequence of policy intervention will also be essential for ensuring the successful decarbonisation of UK steel production in line with the chosen targets. As outlined above, the short-term measures must be implemented within this year or next to ensure the steel industry is in a position to start attracting investment for a significant reduction of emissions.

There will also be an overlap of particular policies such as free allocations and other carbon leakage measures (such as Carbon Border Adjustment Mechanism or Product Standards), where free allocations are slowly phased out while the replacement policy is gradually implemented. As the carbon leakage protections are too vital to guarantee continued production in the UK, free allocations cannot be phased out before and until its replacement has been proven to work without unintended consequences.

Finally, some policies will not need to be implemented urgently. CCUS infrastructure, for example, depends on the deployment of CCUS capture plants, and decarbonisation of heating would depend on a significant and guaranteed supply of hydrogen, which is expected to be some years away. Some policies will also take years to develop, such as Carbon Border Adjustment Mechanism or Product Standards, but must match the EU's timescale to avoid unintended consequences. However, an announcement of the start of policy development or commitment to the eventual implementation of the policies will be essential to ensure investor confidence.

# 9. COMPARING PROGRESS

To enable the decarbonisation of steel production, there is a need to change the business environment with new policies and additional support. This report has outlined the need for new policy interventions in relation to a broader range of cross-cutting areas, including industrial electricity prices, steel scrap supply, international trading environment, product standards, CCUS/hydrogen infrastructure, public procurement, and new support for energy efficiency, R&D, and decarbonised heat. Additionally, policies to support CCUS and hydrogen business cases need to be negotiated bilaterally.

The race towards Net Zero has started, and there are growing concerns that the UK is being left behind on industrial decarbonisation. Other countries also recognise the need to support the decarbonisation of their steel industries and provide the necessary support. Below is an overview of the policies and progress made in the UK, France, Germany, and Canada:

| | | France | Germany | Canada | UK |
|---|---|---|---|---|---|
| 1. | Parity of industrial electricity prices | ☑ | ☑ | ☑ | ⊟ |
| 2. | Energy efficiency funding | ☑ | ☑ | ☑ | ⊟ |
| 3. | Improved scrap utilisation and quality | ⊟ | ⊟ | ⊟ | ☒ |
| 4. | Steel Innovation Funding | ☑ | ☑ | ⊟ | ⊟ |
| 5. | Carbon Border Adjustment Mechanism or Product Standards | ☑ | ☑ | ⊟ | ⊟ |
| 6. | Green public procurement | ☒ | ☒ | ☒ | ☒ |
| 7. | Policy to ensure competitiveness/CAPEX support | ☑ | ☑ | ☑ | ☒ |
| 8. | Access to CCS/hydrogen infrastructure | ⊟ | ⊟ | ☑ | ⊟ |
| 9. | Low-carbon hydrogen | ☑ | ☑ | ⊟ | ⊟ |

Note: UK Steel analysis is based on desk-based research and is not an exhaustive list of all country's measures, policies, and programmes.

The above indicates that additional policy development would be needed to stay at the vanguard of Net Zero steel production. Over the past years, other comparable countries have developed targeted policies to support the transition to low-emission steelmaking, removing barriers, and improving the business environment. To meet the 2035 target, barriers to decarbonisation must be addressed and additional support made available.

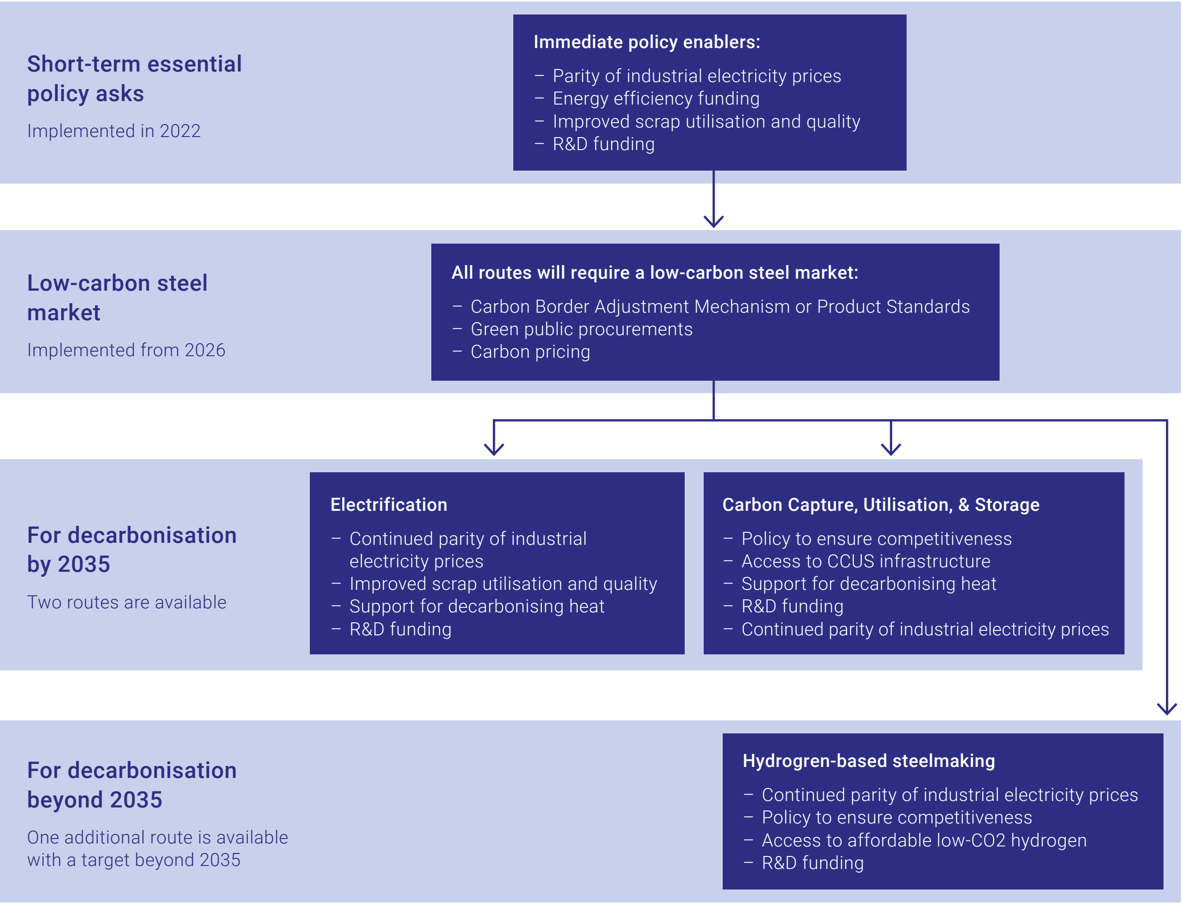
# 10. NEXT STEPS

The steel industry and Government could in partnership transform steel production and create the world's first Net Zero steel sector. There are many technical, economic, and policy challenges to enabling this transition, and it will require significant investment from the industry and policy changes from Government. However, it also offers the prospect of growth and increased steel production in the UK, creating new green jobs and economic activity in local communities.

There are several technology routes in which the sector can significantly reduce its emissions, which require their own mix of supportive policies to enable them. But fundamental to them all is the need for short-term policy changes to improve the business environment to put the steel sector in a sustainable position of growth and profitability. Therefore, in partnership with the industry, the Government must now ensure the immediate policy enablers are put in place: Parity of electricity prices; Energy Efficiency funding; Improved scrap utilisation and quality; and R&D funding.

These policies could unlock the next steps for the steel producers, allowing them to plan their decarbonisation journey, and meet the 2035 target, as recommended by the Climate Change Committee. It is an exciting opportunity for the industry, its employees, and the local communities supporting them, to take the next step towards a modern steel sector. For the Government, it will have demonstrated immeasurable leadership, after being the first major economy to commit to a Net Zero-emission target, it will enable the UK to be the first major economy to have completely decarbonised its steel production.

**Figure 30 – Decarbonising the steel sector and the needed policy changes**



# 11. ENDNOTES

[1] BEIS (2017), Future Capacities and Capabilities of the UK Steel Industry: Summary Report, BEIS Research Paper Number 26, 15 December 2017, https://www.gov.uk/government/publications/uk-steel-industry-future-market-opportunities

23% of territorial emissions and 5% of consumption-based emissions.

[3] WorldSteel, 2020 World Steel in Figures, Average growth rates % per annum: 2000-05: 6.2%; 2005-10: 4.5%; 2010-2015: 2.5%; and 2015-2019: 3.6%.

[4] Lightweight, heavy impact (2016) McKinsey & Company. Figures presented in the context of materials used in car bodies.

[5] Climate Change Committee, The Sixth Carbon Budget, The UK's path to Net Zero, December 2020

[6] WorldSteel, https://www.worldsteel.org/steel-by-topic/steel-markets/transport.html

[7] HS2, Carbon – putting Britain on track to a net zero carbon future, https://www.hs2.org.uk/why/carbon/#:~:text=Transporting%20freight%20by%20rail%20reduces,zero%20carbon%20emissions%20by%202050

[8] APEAL 2020, Recycling, https://www.apeal.org/recycling/

[9] Eurofer (2012), The recycling and reuse survey, https://www.steelconstruction.info/The_recycling_and_reuse_survey#The_2012_Eurofer_survey_of_NFDC_Members

[10] BCG (2013), Steel's Contribution to a Low-Carbon Europe 2050, https://image-src.bcg.com/Images/Steel_Contribution_June_2013_tcm38-97801.pdf

[11] Industrial Decarbonisation & Energy Efficiency Roadmaps to 2050, Iron and Steel, March 2015, DNV-GL for BEIS

[12] WorldSteel

[13] WorldSteel, $CO_2$ Data Collection Summary Report 2018

[14] WorldSteel, World Steel in Figures 2019

[15] WorldSteel, Steel's Contribution to A Low Carbon Future and Climate Resilient Societies, WorldSteel Position Paper

[16] UK Steel analysis, 2021.

[17] International Steel Statistics Bureau, 2021

[18] BEIS, 2018 UK Greenhouse Gas Emissions, Final figures, 4 February 2020, (UK emissions 451.5 MtCO$_2$e). CCC Net Zero Technical report, May 2019 (Industrial emissions 105 MtCO$_2$e).

[19] ONS (2019), The decoupling of economic growth from carbon emissions: UK evidence

[20] Ibid

[21] Ibid

[22] WorldSteel, $CO_2$ Data Collection Summary Report 2018

[23] Allwood, J., Dunant, C., Lupton, R., & Gonzalez Cabrera Honorio Serrenho, A. (2019). Steel Arising: Opportunities for the UK in a transforming global steel industry.

[24] Defra conversion factor for large container vessel of 0.01267 kgCO2e/tonne product/km shipped. Shipping distance from Shanghai to Dover of 22,000 km. Estimated CO$_2$e emissions of 278 kg per tonne.

[25] UK Steel (2021), A barrier to decarbonisation: Industrial electricity prices faced by UK steelmakers, https://www.makeuk.org/insights/reports/a-barrier-to-decarbonisation-industrial-electricity-prices-faced-by-uk-steelmakers

[26] Conversion costs are a manufacturer's production costs other than the cost of a product's direct materials and includes labour costs.

[27] UK Government (2015), Industrial Decarbonisation & Energy Efficiency Roadmaps to 2050, March 2015

[28] UK Government (2015), Industrial Decarbonisation & Energy Efficiency Roadmaps to 2050, March 2015

[29] UK Government (2015), Industrial Decarbonisation & Energy Efficiency Roadmaps to 2050, March 2015

[30] Institution of Civil Engineers. (2003). Proceedings of the Institution of Civil Engineers: Engineering Sustainability. Institution of Civil Engineers.

[31] Turkey 2020 Report Communication EU Parliament, Council, Commission and EESC - Enlargement Policy - Brussels, 6.10.2020, SWD(2020) 355 final, https://ec.europa.eu/neighbourhood-enlargement/sites/near/files/turkey_report_2020.pdf

[32] Indian Ministry of Environment and Forests – Notification 31 March 2012 – Integrated Iron & Steel Standards, amending Environment Protection Rules (1986), https://parivesh.nic.in/writereaddata/ENV/envstandard/envstandard15.pdf

[33] S&P Global Platts (2022), Russia mulls raising export duty on ferrous scrap to $324/mt: Ruslom, https://www.spglobal.com/commodityinsights/en/market-insights/latest-news/metals/033022-russia-mulls-raising-export-duty-on-ferrous-scrap-to-324mt-ruslom

[34] Argus Media (2021), Ukraine trebles ferrous scrap export duty, https://www.argusmedia.com/en/news/2279868-ukraine-trebles-ferrous-scrap-export-duty

[35] BEIS (2020), Research Fund for Coal and Steel: UK funding for 2020 call for proposals, 27 August 2020, https://www.gov.uk/government/publications/research-fund-for-coal-and-steel-uk-funding-for-2020-call-for-proposals/research-fund-for-coal-and-steel-uk-funding-for-2020-call-for-proposals

[36] Mehling, M. A., van Asselt, H., Das, K., Droege, S., & Verkuijl, C. (2019). Designing border carbon adjustments for enhanced climate action. American Journal of International Law, 113(3), 433-481.

[37] International Steel Statistics Bureau, Markets with similar carbon price include EU, Norway, Switzerland, New Zealand, and Canada.

[38] Mehling, M. A., van Asselt, H., Das, K., Droege, S., & Verkuijl, C. (2019). Designing border carbon adjustments for enhanced climate action.

American Journal of International Law, 113(3), 433-481.

[39] Mehling, M. A., van Asselt, H., Das, K., Droege, S., & Verkuijl, C. (2019). Designing border carbon adjustments for enhanced climate action. American Journal of International Law, 113(3), 433-481.

[40] Sandbag (2019), The A-B-C of BCAs, An overview of the issues around introducing Border Carbon Adjustments in the EU.

[41] Climate Strategies (2019), Inclusive Transformation of the European Materials Sector, https://climatestrategies.org/publication/inclusive-transformation-materials/

[42] Climate Strategies (2019), Inclusive Transformation of the European Materials Sector, https://climatestrategies.org/publication/inclusive-transformation-materials/

[43] Procurement policy note 11/16: procuring steel in major projects - revised guidance

[44] Grantham Research Institute on Climate Change and the Environment (2018), What is a carbon price and why do we need one?, London School of Economics and Political Science, http://www.lse.ac.uk/GranthamInstitute/faqs/what-is-a-carbon-price-and-why-do-we-need-one/

[45] HM Treasury (2021): *Net Zero Review - Analysis exploring the key issues*, https://www.gov.uk/government/publications/net-zero-review-final-report

[46] Vogl, V., Åhman, M., & Nilsson, L. J. (2018). Assessment of hydrogen direct reduction for fossil-free steelmaking. Journal of Cleaner Production, 203, 736-745

[47] Åhman, Max, Olle Olsson, Valentin Vogl, Björn Nyqvist, Aaron Maltais, Lars J. Nilsson, Kalle Hallding, Kristian Skåneberg, and Måns Nilsson. (2018). "Hydrogen steelmaking for a low-carbon economy: A joint LU-SEI working paper for the HYBRIT project." EESS report 109.

[48] Institute for European Studies, Table A. Overview of breakthrough low-CO2 iron and steel production technologies, https://www.ies.be/files/ANNEX_Technology_Database_13072018.pdf

[49] Gas Goes Green (2021), DNV-GL & Energy Network Association, Britain's Hydrogen Network Plan

[50] Industry estimates at £43-£65 per ton $CO_2$ captured and £18-£36 per ton $CO_2$ injected for transport and storage. The specific costs depend on the locations, local models for the network, and accounts for variations in gas preparation prior to injection in to the network.

[51] This assumes 2 tonnes of carbon per tonnes of steel, £65/$tCO_2e$, 90% capture rate, and a base costs of £460 per tonnes of steel.

[52] Budinis, S., Krevor, S., Mac Dowell, N., Brandon, N., & Hawkes, A. (2018). An assessment of CCS costs, barriers and potential. Energy strategy reviews, 22, 61-81.

[53] Element Energy (2014), Demonstrating CO2 capture in the UK cement, chemicals, iron and steel and oil refining sectors by 2025: A Techno-economic Study

[54] HYBRIT, Steel making today and tomorrow

[55] Materials Processing Institute, 2019.

[56] Vogl, V., Åhman, M., & Nilsson, L. J. (2018). Assessment of hydrogen direct reduction for fossil-free steelmaking. Journal of Cleaner Production, 203, 736-745

[57] MIDREX (2020), Ultra-Low CO2 Ironmaking: Transitioning to the Hydrogen Economy, Vincent F. Chevrier, https://www.midrex.com/tech-article/ultra-low-co2-ironmaking-transitioning-to-the-hydrogen-economy/

[58] Syndex (2021), Decarbonisation of the Steel Industry in the UK - Toward a mutualised green solution, March 2021

[59] HYBRIT, Summary of findings from HYBRIT Pre-Feasibility Study 2016–2017

[60] BNEF (2020), Hydrogen Economy Outlook, Key messages, 30 March 2020

[61] Vogl, V., Åhman, M., & Nilsson, L. J. (2018). Assessment of hydrogen direct reduction for fossil-free steelmaking. Journal of Cleaner Production, 203, 736-745.

[62] Element Energy (2018), Industrial Fuel Switching Market Engagement Study.

[63] Ollikainen, Marjo (2020), Jätti-investointi vähentää 7 prosenttia Suomen hiilidioksidipäästöistä – SSAB:n investointi ja bisnes ovat mallikappale teknologiateollisuuden kädenjäljestä, Teknologiateollisuus.fi

[64] Hy4Heat, Industrial Hydrogen Appliances, Draft report.

[65] Syndex (2021), Decarbonisation of The Steel Industry in the UK - Toward A Mutualised Green Solution, March 2021, https://www.mpiuk.com/downloads/industry-papers/SI-Series-Paper-05-Decarbonisation-of-the-Steel-Industry-in-the-UK.pdf

[66] Element Energy (2018), Industrial Fuel Switching Market Engagement Study.

[67] Committee on Climate Change (2018), Hydrogen in a low-carbon economy, November 2018.

[68] Coats, D. (2021) Managing the challenges of technology, trade, climate change and COVID-19.

[69] Coats, D. (2021) Managing the challenges of technology, trade, climate change and COVID-19.

[70] BEIS (2017), Future Capacities and Capabilities of the UK Steel Industry: Summary Report, BEIS Research Paper Number 26, 15 December 2017, https://www.gov.uk/government/publications/uk-steel-industry-future-market-opportunities

[71] BEIS (2017), Future Capacities and Capabilities of the UK Steel Industry: Summary Report, BEIS Research Paper Number 26, 15 December 2017, https://www.gov.uk/government/publications/uk-steel-industry-future-market-opportunities

[72] Ibid.

## Comparing progress supporting elements:

**France**:

1. UK Steel (2021), A Barrier to Decarbonisation; The French Steel Plan (Plan sidérurgie) guarantees access to competitive and carbon-free electricity in the long term
2. Plan France Relance, £1bn fund for industrial energy efficiency, https://www.iea.org/policies/11958-recovery-and-resilience-plan-ecology-and-biodiversity-industry-decarbonisation; Financing for Energy Efficiency Investments https://www.iea.org/policies/1363-financing-for-energy-efficiency-investments
3. France had a net export of 5.4m tonnes of steel scrap in 2021; European calls for export limitations, https://www.spglobal.com/commodityinsights/en/market-insights/latest-news/metals/042221-eurofer-stresses-need-to-stop-eu-scrap-exports-for-non-green-steel
4. As a member of the EU, the French Steel sector has access to the established European Research Fund for Coal and Steel (RFCS). The French Recovery and Resilience plan, £2.9bn into green technologies, reincorporation of recycled materials, https://www.iea.org/policies/13265-recovery-and-resilience-plan-green-energies-and-techologies-rd-and-innovation
5. The EU is developing a Carbon Border Adjustment Mechanism for gradual implementation from 2023-26
6. There are general policies to support the public procurement of green products, but none yet on steel specifically; Climate Works Foundation (2019), Curbing Carbon from Consumption: The Role of Green Public Procurement, https://www.climateworks.org/wp-content/uploads/2019/09/Green-Public-Procurement-Final-28Aug2019.pdf
7. "France 2030" Investment Plan, £4.8bn for industrial decarbonisation, https://www.iea.org/policies/14279-france-2030-investment-plan; French government provided the investment of £1.4bn and signed strategic partnership with ArcelorMittal for the investments into EAF in Dunkirk, https://www.metalbulletin.com/Article/5083735/ArcelorMittal-to-replace-3-blast-furnaces-with-EAF-DRI-plants-in-drive-to-decarbonize-French.html
8. The French Hydrogen Strategy included support for hydrogen infrastructure, but no clear plans for timelines or coverage, https://www.bdi.fr/wp-content/uploads/2020/03/PressKitProvisionalDraft-National-strategy-for-the-development-of-decarbonised-and-renewable-hydrogen-in-France.pdf
9. France aims to install 6.5-10 GW of green hydrogen, with secured funding of £6bn, https://www.climatechangenews.com/2020/09/10/france-seeks-german-collaboration-hydrogen-eu-green-recovery/, https://www.spglobal.com/marketintelligence/en/news-insights/latest-news-headlines/france-launches-8364-7b-clean-hydrogen-plan-with-early-focus-on-industrial-emissions-60260381;

**Germany:**

1. *UK Steel (2021) A Barrier to Decarbonisation*
2. The Energieeffizienzfonds with an annual budget of £100m for energy efficiency measures in industry, https://www.iea.org/policies/2623-energy-efficiency-fund; The Energieeffizienz in der Wirtschaft – Zuschuss und Kredit funds energy efficiency investments in industry via grants and loans, The Energieeffizienz in der Wirtschaft – Wettbewerb funds energy efficiency investments in industry via competitions rounds, https://www.iea.org/policies/7714-federal-funding-for-energy-efficiency-in-the-economy-funding-competition; The £2.8bn German Development and Resilience Plan (DARP) includes £385m funding for a support program for decarbonisation in industry, https://www.iea.org/policies/13984-german-development-and-resilience-plan-darp-11-decarbonisation;
3. Germany had a net export of 3m tonnes of steel scrap in 2021, which is little compared to its economy and steel sector size; European calls for export limitations, https://www.spglobal.com/commodityinsights/en/market-insights/latest-news/metals/042221-eurofer-stresses-need-to-stop-eu-scrap-exports-for-non-green-steel
4. As a member of the EU, the French Steel sector has access to the established European RFCS. R&D funding for CCUS, https://www.iea.org/policies/13194-co2-avoidance-and-use-in-raw-material-industries; Pilot program 'Einsparzaehler' support pilot projects aimed at energy efficiency, https://www.iea.org/policies/2218-pilot-program-einsparzaehler.
5. The EU is developing a Carbon Border Adjustment Mechanism for gradual implementation from 2023-26
6. There are general policies to support the public procurement of green products, but none yet on steel specifically; Climate Works Foundation (2019), Curbing Carbon from Consumption: The Role of Green Public Procurement, https://www.climateworks.org/wp-content/uploads/2019/09/Green-Public-Procurement-Final-28Aug2019.pdf
7. German Government invests £48m in ArcelorMittal's hydrogen DRI plant, https://corporate.arcelormittal.com/media/news-articles/german-federal-government-commits-its-intention-to-provide-55-million-of-funding-for-arcelormittal-s-hydrogen-dri-plant; German government presented plans for Contracts for Difference to fund steel decarbonisation,
8. Policies for hydrogen grids are being developed by the German Federal Network Agency, including federal hydrogen infrastructure.
9. The £2.8bn German Development and Resilience Plan (DARP) includes £1.3bn for hydrogen projects and £600m for hydrogen research and innovation https://www.iea.org/policies/13984-german-development-and-resilience-plan-darp-11-decarbonisation; In 2020, the German Government committed £6bn to support 5GW hydrogen capacity,

**Canada:**

1. Canada has parity of industrial electricity prices within their region: BEIS (2021), International industrial energy prices. While these datasets are often difficult to use as they do not take account of exemption and compensation schemes, they do show an overall trend, https://www.gov.uk/government/statistical-data-sets/international-industrial-energy-prices.
2. The £1.9bn Strategic Innovation Fund's Net-Zero Accelerator Fund supports industrial decarbonisation and energy efficiency, https://www.iea.org/policies/12692-a-healthy-environment-and-a-healthy-economy-clean-industry
3. Canada had an average net export of 3.2m tonnes of steel scrap in 2019-2021.
4. The Canadian Strategic Innovation Fund has supported several steel projects, https://www.ic.gc.ca/eic/site/125.nsf/eng/00022.html
5. The Canadian Government consulted on a Carbon Border Adjustment Mechanism in 2021, but the government has not yet published its response to the consultation, https://www.canada.ca/en/department-finance/programs/consultations/2021/border-carbon-adjustments.html
6. –
7. Canadian Government has invested £230m in the Arcelor Mittal DRI plant and £250m in the Algoma Steel EAF plant, https://algoma.com/government-of-canada-endorses-algoma-steels-transformation-plan-for-green-steel-commitment-of-up-to-420-million/, https://www.canada.ca/en/innovation-science-economic-development/news/2021/07/government-investing-in-hamiltons-steel-industry-to-support-good-jobs-and-significantly-reduce-emissions.html
8. Canada's Hydrogen Strategy aims to have a liquid hydrogen network available Canada wide by 2030, https://www.nrcan.gc.ca/climate-change-adapting-impacts-and-reducing-emissions/canadas-green-future/the-hydrogen-strategy/23080
9. Canadian Government investing £0.9bn in a Low-carbon and Zero-emissions Fuels Fund to increase the production and use of low-carbon fuels, https://www.iea.org/policies/12692-a-healthy-environment-and-a-healthy-economy-clean-industry; Canada's Hydrogen Strategy includes an annual target of 4Mt hydrogen production by 2030, https://www.nrcan.gc.ca/climate-change-adapting-impacts-and-reducing-emissions/canadas-green-future/the-hydrogen-strategy/23080

**UK:**

1. Between 2013 and 2015, the Coalition Government introduced several measures to reduce electricity prices for the most electro-intensive industries, including carbon price compensation and exemptions from the cost of renewables. These went a considerable way to addressing the situation but never fully addressed the issue for UK steelmakers. The British Energy Security Strategy announced two new measures to reduce the electricity price disparity between steelmakers in the UK, France, and Germany. If implemented, these would reduce about half of the politically controlled elements of bills, leaving network charges and the Capacity Market levy to be addressed. UK Steel (2021), A Barrier to Decarbonisation illustrates the gap in industrial electricity prices between the UK, France, and Germany.
2. The Industrial Energy Transformation Fund has a budget of £315m over four years, but the Clean Steel Fund has not been allocated a budget. Progress has been made in the UK with the IETF funding and Industrial Heat Recovery Support (IHRS) programme before then. However, the budgets of similar programmes in Germany, France, and Canada dwarf those available in the UK.
3. The UK has a net export of 8m tonnes of steel scrap in 2021, which is comparatively higher considering its steel sector size.
4. Following Brexit, the UK steel sector lost access to the European RFCS and Steel, which provide a long-term, stable, and steel-dedicated source of innovation funding. The UK Government has provided some shorter-term funding for the sector, including the SUSTAIN and PRISM programmes*, and many steel relevant funding pots through the Industrial Strategy Challenge Fund – but there is a need to replicate the long-term internationally collaborative model provided by the European RFCS. While various innovation programmes are available from the UK Government, most relevantly the Transforming Foundation Industries Challenge Fund, a dedicated fund for the steel sector does not exist. After leaving the EU, the UK steel sector lost access to the EU's dedicated innovation fund, the Research Fund for Coal and Steel.
5. The Government has announced that it will be consulting on CBAMs and Product Standards by the end of 2022.
6. -
7. A business model is being developed for industrial CCUS, however, it is still under development. No direct CAPEX funding is available for electrification or hydrogen DRI.
8. -
9. The Hydrogen Strategy outlined an ambition for 5GW blue & green hydrogen by 2030, £55m for industrial fuel switching, and £240 million Hydrogen Net Zero Fund. The British Energy Security Strategy doubled this ambition up to 10GW of hydrogen production by 2030. Although likely delivered via hydrogen tariff on natural gas, funding is still unclear https://www.gov.uk/government/publications/british-energy-security-strategy/british-energy-security-strategy#hydrogen.

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*https://www.sustainsteel.ac.uk/ and https://www.mpiuk.com/prism.htm

UK Steel is the trade association for the UK steel industry and champions the country's steel manufacturers.

We represent the sector's interests to government and promote our innovative, vibrant and dynamic industry to the public.

**Together, we build the future of the UK steel industry.**

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