Building the future

green alliance...

A faster route to clean steel

Building the future
A faster route to clean steel

Authors
By Verner Viisainen, Holly Rowden,
Dustin Benton and Roz Bulleid

Acknowledgements
With thanks to Valentin Vogl at Lund University, Dr Andrew Pimm at the University of Leeds and Professor Michael Grubb at University College London for helping to shape our analysis and recommendations. Thanks also to the many steel industry representatives and stakeholders who we consulted while writing this report.

We are grateful to LIBERTY Steel Group for supporting this work.

Green Alliance
Green Alliance is an independent think tank and charity focused on ambitious leadership for the environment. Since 1979, we have been working with the most influential leaders in business, NGOs and politics to accelerate political action and create transformative policy for a green and prosperous UK.

The Green Alliance Trust
Registered charity no 1045395
Company limited by guarantee
(England and Wales) no. 3037633

Published by Green Alliance
July 2022

ISBN 978-1-912393-76-3

Designed by Howdy

Contents

Summary

> **Steel will continue to be essential as we transition to a net zero economy.”**

The UK was the birthplace of the modern steel industry, an industry that lies at the heart of communities, feeding important supply chains and infrastructure up and down the country.

There are six main steelmaking sites in the UK. Between them, they supply flat steel to car plants in Sunderland and Solihull, among others, while meeting close to half of UK automotive sector demand.[1] They provide 96 per cent of steel for UK rail, as well as making a range of specialist parts for the defence and aerospace industries. They also supply the construction sector, including all the structural steel for building Hinkley Point C nuclear power station.[2,3]

Steel will continue to be essential as we transition to a net zero economy. It is used in buildings, manufactured goods and infrastructure, as well as for green economic solutions, such as electric vehicles and renewables. Embracing clean steelmaking is also an opportunity to reinvigorate the industry, building on its strong foundation as part of the UK’s industrial and cultural heritage while adapting to modern manufacturing, eg for metal 3D printing, to create good, secure jobs and help to level up the country.

However, most UK produced steel is still high carbon. The industry is responsible for 15 per cent of total UK industrial emissions.[4] Important markets are already asking for cleaner steel and there are deadlines for

> **Important markets are already starting to ask for a greener product."**

plant renovation due this decade, which will be opportunities for the government and industry to act. If the whole industry does not shift to lower carbon production, already ageing steel assets will become increasingly obsolete and the country will miss the chance to put this strategically important sector at the heart of its efforts to achieve a net zero carbon economy.

The war in Ukraine and the energy price crisis have exacerbated existing problems, such as high industrial electricity costs and global overcapacity in the steel sector.

Rapidly shifting more UK steelmaking towards electric production, using scrap steel and electric arc furnaces (EAFs), would offer guaranteed emissions reductions in the short term. Expanding EAFs would also allow the UK to maintain a level of ore-based production in future, based on the hydrogen direct reduction process.

The UK is better placed than most countries to expand EAF steel production. It produces more scrap each year than virgin steel but much of this valuable resource is exported overseas, rather than used domestically. With the right incentives and standards to encourage higher quality scrap processing and a domestic scrap market, a more resilient and resource efficient steel sector could be created.

Increasing clean steel production is a chance to futureproof the industry as well as boosting the wider UK economy. We conclude that using a combination of electrification and hydrogen direct reduction processes would reduce the industry's CO_2 emissions by 87 per cent by 2035, while increasing its productivity by 85 per cent. It could also potentially

> **"The government and industry have discussed decarbonising the steel sector for years, but progress has stalled."**

create more jobs overall in former industrial heartlands and around new industrial clusters, while cutting UK exposure to global commodity risks.

The government and industry have discussed decarbonising the steel sector for years, but progress has stalled over the policy and financial support the industry says it needs to deliver a cleaner future while remaining competitive.

It is over a year since the publication of the *Industrial decarbonisation strategy*, in which the government promised to consider setting a 2035 decarbonisation target for the steel sector, but so far there has been no decision on a way forward. The window for action is closing as deadlines for repairing existing blast furnaces approach and European steelmakers race ahead with their clean steel plans. The government should move forward with measures that encourage the transition to clean steel, in exchange for a promise of more action by the steel industry.

We recommend the following:

A joint government-industry target of at least 85 per cent reduction in total UK steelmaking emissions by 2035 (relative to 2019 levels). This is aligned with the Climate Change Committee's recommendation for near zero ore-based steelmaking by 2035.

A 'green power pool' to bring the benefits of cheap electricity from renewables directly to energy intensive industries that can show this will transform their decarbonisation plans

> “Material efficiency measures alone could cut the sector’s emissions globally by at least 21 per cent.”

Incentives for the domestic retention of scrap steel to ensure a higher quality scrap supply for domestic producers and enable a lower carbon, more circular UK steel industry, better protected against global supply chain shocks.

A UK carbon border adjustment mechanism or product standards for imported steel, to prevent UK producers being undercut by cheap imported steel and to help ensure low carbon imports.

These actions should be part of wider measures to support industrial decarbonisation, some of which the government is already delivering. This includes: continued support for clean steel R&D funding and industrial energy efficiency; infrastructure and policy to ensure hydrogen availability for industrial uses; a net zero aligned emissions trading scheme; and consolidated markets for lower carbon, resource efficient industrial products that help to address higher production costs.

In this report, we focus on steel production, but it will be equally important to ensure the efficient use and reuse of this valuable resource. Estimates suggest material efficiency measures alone could cut the sector’s emissions globally by at least 21 per cent.[5] As the UK imports around 60 per cent of its steel, any reduction in demand need not result in a smaller UK steel industry.[6] Instead, it could help in the development of new products and business models for export. We will follow this report with further analysis of issues around future demand and resource efficiency.

Introduction

> **"Futureproofing the steel industry should be part of the government's levelling up ambition."**

The steel industry is vital to local economies, and regional and national supply chains in the UK. There are six main steelmaking sites located between south Wales and Yorkshire and the Humber: Tata and Celsa in South Wales, Liberty, Outokumpu and Sheffield Forgemasters around Sheffield, and British Steel in Scunthorpe, in addition to a range of steel processing sites.

Steel is integral to a revitalised and net zero aligned manufacturing sector. It can also help enhance self sufficiency, in the light of global supply chain shocks, particularly by switching to greater use of scrap metal as an input, over imported iron ore and coal. This would involve greater use of existing EAF technology (Scrap-EAF).

Besides its direct employees, whose skills attract 33 per cent above the national median wage, the industry supports a further 42,000 indirect jobs and helps to maintain a wider industrial ecosystem.[7] These well paying jobs are also primarily located in less economically advantaged regions. Futureproofing the steel industry should be part of the government's levelling up ambition.

Steel is fundamental to the net zero economy, for instance in producing wind turbines, solar panels and electric vehicles.[8] So it makes sense to prioritise more local, circular production and become less reliant on imports. The UK should seize this moment to rebuild its steel sector with a new vision.

“Supportive policy for steel decarbonisation could attract private investment and improve productivity.”

Shifting traditional heavy industries to low carbon production is well supported. Polling in 2021 showed that two thirds of voters thought it was important.[9]

Here, we set out how supportive policy for steel decarbonisation could also attract private investment and improve productivity, leaving it in far better shape for the coming decades. While most of the measures we propose are directed at the biggest sources of emissions, they would also provide a more stable operating environment for those producers that already have lower emissions.

The world wants clean steel

> **"Governments globally are taking actions likely to increase barriers to market for carbon intensive steel production."**

Motivated by commitments to green their supply chains, some commercial buyers are demanding clean steel, including nearly 20 members of the Climate Group's SteelZero initiative.[10] Car makers BMW Group and Volvo have gone further and are collaborating directly with low carbon steel projects.[11]

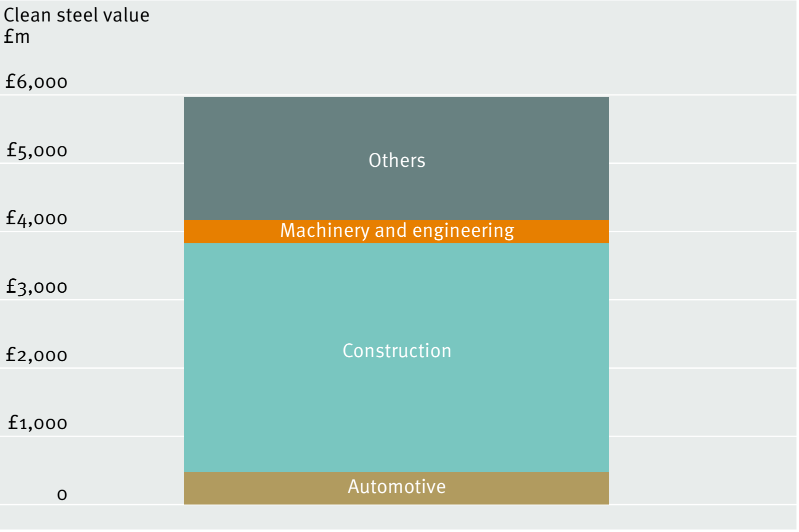
Governments globally are taking actions likely to increase barriers to market for carbon intensive steel production. Examples of this are the joint EU and US steel trade deal, signed in 2021, and the EU carbon border adjustment mechanism, likely to come into force by 2026.[12,13] The former emphasised a desire to move towards lower carbon steel and the latter will add a carbon price on some imports from outside the EU, including on steel. Together the EU and the North American Free Trade Agreement represent 20 per cent of the global market and 87 per cent of the current export market for UK steel producers.[14]

The UK is taking steps along similar lines, promising to address embedded emissions in transport and construction in its net zero strategy.[15] It also brokered announcements at the 2021 COP26 climate summit which established clean steel as the preferred choice for global markets, began an international effort to establish common standards and promised, with four other countries, to shift public procurement towards clean steel.[16,17] It already requires suppliers that bid for major government contracts to commit to achieving net zero by 2050 and publish carbon reduction plans.

Research carried out for the government in 2017 predicted a £6 billion market for steel in the UK in 2030 and it is likely that most of this demand will be for clean steel only. If this is the case, future markets will be closed to steelmakers that have not cut their emissions.

> **"Most UK produced steel continues to be highly carbon intensive."**

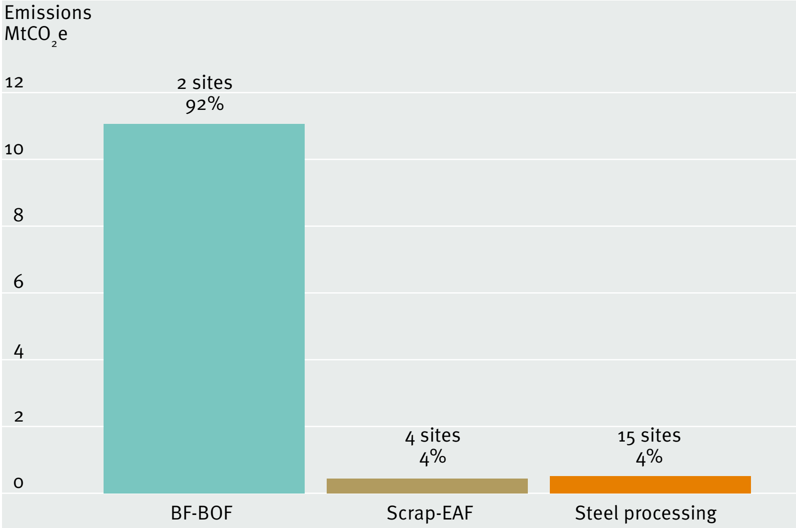
The UK steel market in 2030, if all sectors demand clean steel[18]



However, most UK produced steel continues to be highly carbon intensive, with the industry contributing to 15 per cent of total UK industrial emissions.[19] Over 90 per cent of the direct emissions from UK steelmaking (see the graph on page ten) arise from the two integrated steelmaking sites, Port Talbot and Scunthorpe, that use the blast furnace and basic oxygen furnace (BF-BOF) method of production, where coal is used to derive iron from ore in a blast furnace, which is then turned into steel inside a basic oxygen furnace.

The feasible economic window to reduce the carbon intensity of these two integrated sites is closing: the four operational blast furnaces in the UK are likely to need relining by 2035, with at least two needing it by 2030. Relining refers to an essential repair in which the worn down bricks used to protect the outer structure of the blast furnace are replaced. This is an important decision point for a steel company, due to the capital costs involved. If they avoid shifting to lower carbon technologies at those points, it could delay steel industry decarbonisation, making the UK's 2050 net zero carbon target harder to reach.

Direct emissions from the UK steel industry in 2018[20]

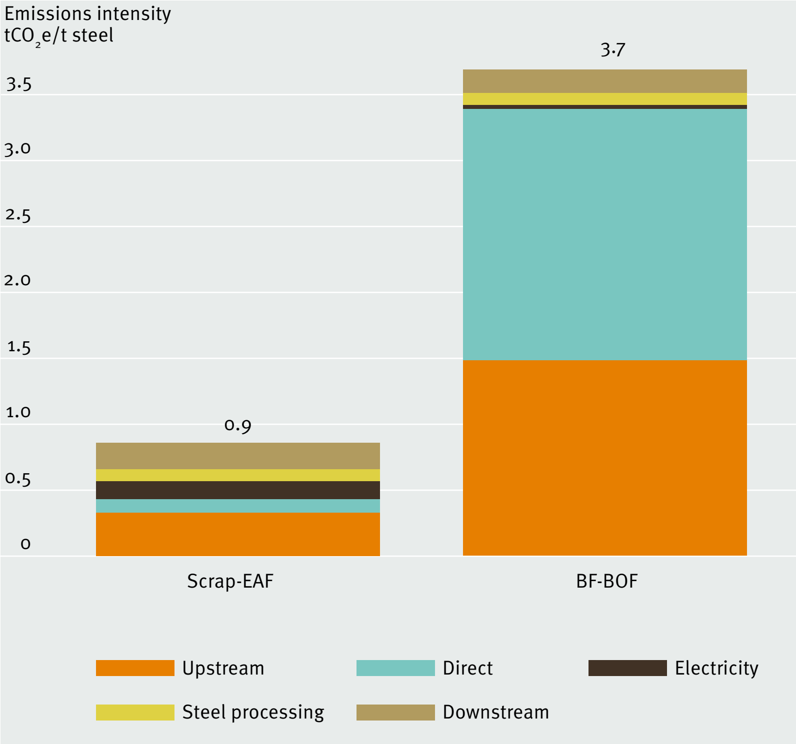


The main source of the direct emissions from the BF-BOF process is the coal used to reduce iron ore to iron before it is turned into steel, producing around 1.9tCO_2e for every tonne of crude steel made in the UK.[21] However, there are additional emissions associated with the mining and transport of raw materials, processing of crude steel and the downstream transport and distribution chain, which together contribute an additional 1.8tCO_2e per tonne of steel produced.

Particularly significant are the methane emissions associated with coal mining which, according to Global Energy Monitor, contribute, on average, 0.43tCO_2e for each tonne of steel.[22] Some scrap steel can be added to the process, reducing emissions, but there is limited capacity for this, up to a maximum of 25 per cent of iron inputs.[23] And it does not always happen in reality, UK BF-BOF scrap steel use is generally lower than this.

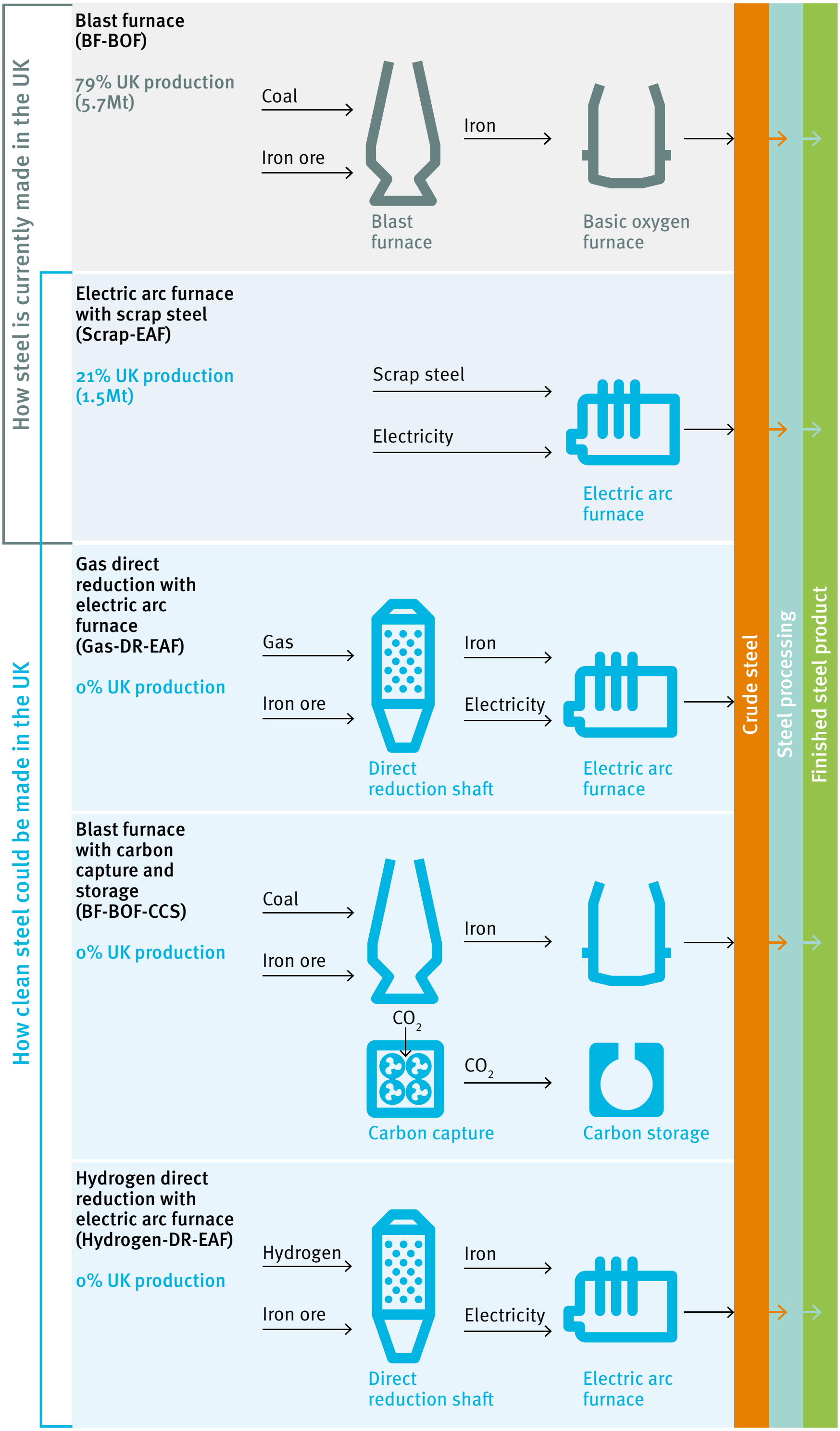
Equivalent emissions from EAFs using scrap steel (Scrap-EAFs) are, on average, 0.9tCO_2e per tonne of steel, based on the emissions intensity of UK electricity and including the emissions associated with processing and transport.

Total emissions from blast furnace steelmaking (BF-BOF) and electrified steelmaking using scrap (Scrap -EAF)[24]



There are limitations around making some steel products with the Scrap-EAF process (see page 13) due to contaminants like copper, but these can be largely addressed through better scrap processing, further innovation or the addition of primary iron where needed.

Processes used to make steel[25]



How steelmaking processes compare under key indicators[26]

	BF-BOF	Scrap-EAF	Gas-DR-EAF	BF-BOF-CCS	Hydrogen-DR-EAF
Availability	Now (but needs replacing)	Now	Now	2025-30	2030 (at scale)
Direct emissions (tCO2/t steel)	1.9	0.1	1	0.7	0.1
Total capital costs (per Mt plant)	£0.04bn*	£0.16bn	£0.35bn	£0.24bn*	£0.49bn
Annual production cost (£/t steel)**	£365*	£292	£485	£404*	£423
Maximum scrap steel use (% of iron input)	25%	100%	100%	25%	100%
Coal use (t/t steel)	0.7	0.012	0.012	0.6	0.012
Steel product range limitations?	None	Some limitations ***	None	None	None

*Based on the cost of blast furnace relining, rather than new plant

**Operational costs and the annual contribution from capital costs, based on an electricity price of £50/MWh (lower than the price in June 2022)

***Such as for thin steel panels used in the automotive and packaging industries

New opportunities in a challenging market

“Russia’s invasion of Ukraine has sharpened the case for a more productive, futureproof sector.”

The UK steel industry has encountered significant challenges in recent years, fuelled by low profit margins due to the global oversupply of steel and ageing infrastructure needing substantial investment.

Since 2015-16, when lack of investor confidence led to the closure of the Redcar steel plant, the UK steel industry has been in a precarious position, and this has been further heightened by recent global events.[27]

Russia’s invasion of Ukraine has sharpened the case for a more productive, futureproof sector, less reliant on global supply chains and less exposed to global commodity prices. In 2019, a third of coking coal used in blast furnaces came from Russia and the invasion has led to higher prices and producers shifting to alternative suppliers. Despite this, there is no case for a new coking coal mine in Cumbria as there is sufficient coal available globally for steelmaking from existing mines and there is little appetite for the highly sulphurous coal that it would produce among UK plants.[28]

In addition, the war has exacerbated already soaring global gas prices and driven an equivalent rise in UK wholesale electricity prices.[29] Industrial electricity prices in 2020 were already 50 per cent higher for UK steelmakers than those faced by competitors in France and Germany.[30]

Although the recent *British energy security strategy* will help to address some of the differences in policy costs by increasing compensation for the indirect carbon costs of electricity for industrial users, network costs for UK firms remain high.[31]

Besides making UK steel less competitive, compared to neighbouring markets, this situation means switching to gas direct reduction, as an interim step, to reduce the emissions from primary steelmaking, is no longer an attractive option.

The crisis has sharpened the need to overhaul the industry but it has also limited the potential technological avenues it can take. Electric and hydrogen powered processes are emerging as the most feasible ways forward.

“Electric and hydrogen powered processes are emerging as the most feasible ways forward.”

Whitehaven coal mine: a white elephant?

As we have previously reported, there is no case for the proposed new metallurgical coal mine in Whitehaven, intended to produce coking coal for steelmaking.[32]

While proponents of the mine claim it will safeguard UK steel, industry experts have said that there is little demand domestically, which will result in most of the coal that would be produced by the mine being exported overseas to countries with lower regulatory standards.[33] As European steel production shifts towards cleaner processes, any remaining local demand for coking coal will also diminish rapidly.

With the government due to make its decision in July 2022, it is important that it bears in mind the advice of the International Energy Agency that no new metallurgical mines will be needed from now on.

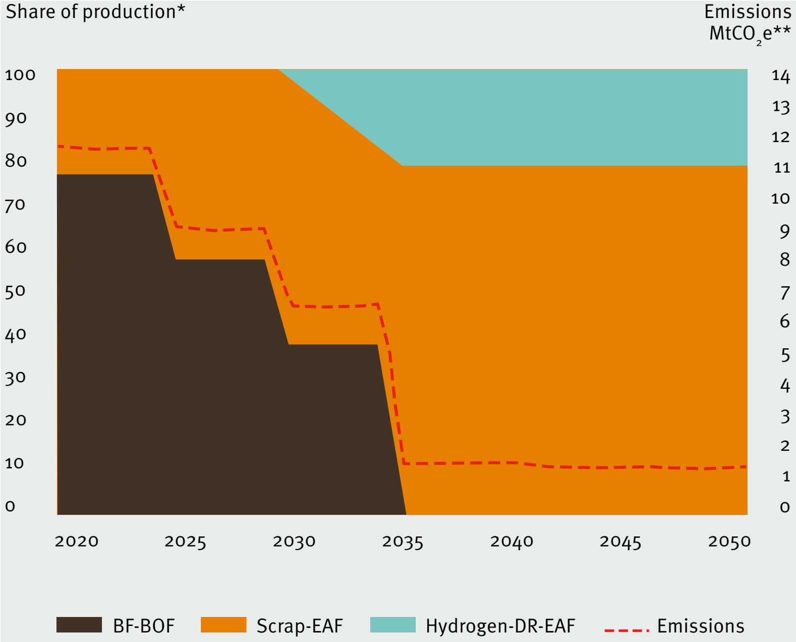
A ‘no regrets’ option

> **Expanding electric arc furnace steel production, while phasing out blast furnaces by 2035, would cut emissions by over 87 per cent.”**

Shifting more UK steel production towards EAFs well before the end of the decade is technically straightforward and will lead to guaranteed emissions reductions.

Our modelling of sector decarbonisation routes, shows that expanding EAF steel production, while phasing out blast furnaces by 2035, would cut emissions by over 87 per cent, relative to 2019 levels, through process substitution and grid decarbonisation. Remaining emissions (1.4Mt in 2050) could be further reduced by targeting the residual emissions from EAFs and processing.

UK steel sector decarbonisation to 2050[34]



*Annual UK production assumed constant at 2019 levels, ie 7.2Mt
**Including steel processing emissions

> It is feasible that commercial hydrogen based steel production could be a fifth of overall production by 2035.”

While EAFs have typically been only used with scrap steel in the UK, in the future they could play an integral role in the hydrogen based production of virgin steel, via direct reduction (Hydrogen-DR-EAF). Instead of using coal, this process uses hydrogen to reduce iron ore in a shaft furnace before the resulting iron is converted to steel in an EAF.

This ability of EAFs to produce batches of finished product with different combinations of scrap and primary iron means expanding their use still allows primary production for the limited range of products that are not possible to make via the Scrap-EAF process. Assuming the hydrogen used is green, the Hydrogen-DR-EAF process has an equivalent direct emissions intensity to Scrap-EAF at $0.1tCO_2$ per tonne of steel, as the reduction process results in no carbon emissions.

If the right steps are taken now, it is feasible that commercial hydrogen based steel production could be operational in the UK by 2030 and could scale up rapidly to be a fifth of overall production by 2035, in line with the phase out of blast furnaces.[35]

Tackling residual emissions

As well as moving away from traditional blast furnace steelmaking towards EAFs and decarbonising electricity production, residual emissions from the EAF process, as shown on page 18, need to be addressed to bring them close to zero. These are relatively low and some potential solutions have already been proposed. However, further R&D will be needed to scale up for commercial use. Hydrogen use will require either connection to a hydrogen supply network or onsite generation capacity and a supportive financial framework.

> Residual emissions from the EAF process need to be addressed to bring them close to zero."

Residual emissions from EAF steelmaking

Step	Emissions source	Use	Direct emissions intensity (tCO_2/t steel)	Possible alternatives
Electric arc furnace	Lime	To help create slag that removes impurities	0.04	Cement paste recycling[36]
	Carbon electrode	To create the electric charge to melt steel	0.007	Essential but electrode wear can be reduced[37]
	Coal	To add carbon to the steel (to make it stronger) and help create slag	0.043	Biomass (eg charcoal, waste rubber)[38]
	Gas	To preheat ladles for steelmaking	0.01	Biogas[39] Hydrogen
Steel processing	Gas	To preheat equipment and melt steel for processing	0.09	Biogas Hydrogen Induction heating

Barriers to electrifying steelmaking

"Limited availability of high quality scrap steel is a major barrier."

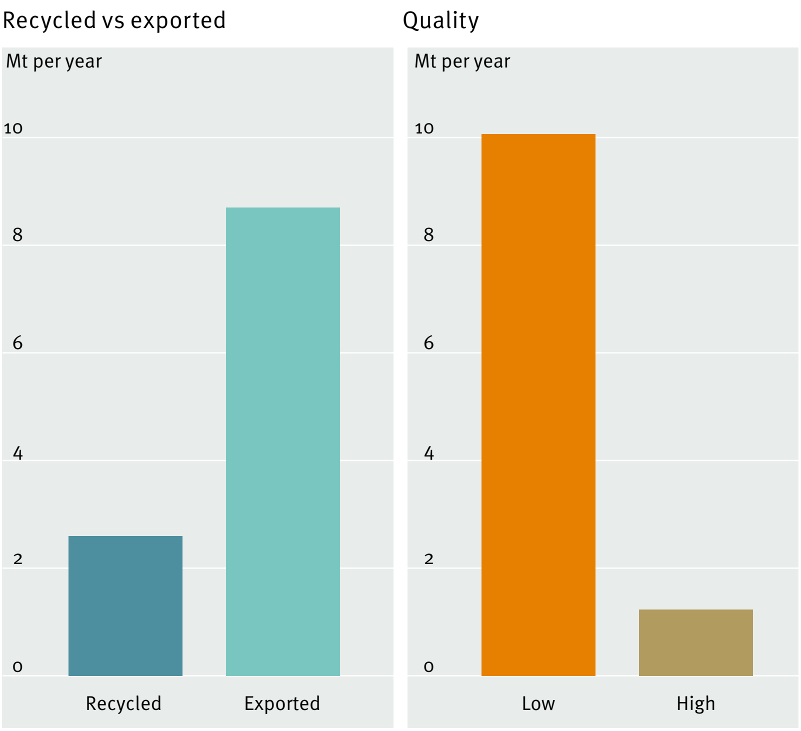
The decarbonisation route we have modelled requires a four fold increase in electricity use by the steel industry by 2035 (from 1.8TWh to 8.8TWh) although this is still less than two per cent of overall projected electricity use in 2035.[40] It also requires more than doubling the volume of scrap steel used by the same point (from 2.6Mt to 6.8Mt), with more of this needing to be high quality scrap for the Scrap-EAF process.

High industrial electricity prices are a significant obstruction to decarbonising the UK's steel industry. Comparable countries with greater sector electrification, via EAFs, tend to be those with lower electricity prices. For example, the US and Turkey have standard industrial electricity prices close to half of those in the UK (£54 per MWh and £70 per MWh respectively, compared to £113 per MWh in the UK in 2019), while having a much greater share of EAF steel production (70 per cent each compared to 21 per cent for UK).[41,42]

Limited availability of high quality scrap steel is also a major barrier. The UK currently generates more than 11Mt of scrap steel every year but much of this is poor quality and ends up being exported overseas, rather than being processed and sold to the domestic market (see graph on page 20). The industry is concerned about increased competition for scrap steel with the shift to EAFs, which need higher quality inputs compared to blast furnaces. Better processing of existing scrap would also allow steelmakers to use it for a wider range of end products. We discuss the possible measures that can be taken to encourage this later in this report.

> Industry is concerned about increased competition for scrap steel with the shift to electric arc furnaces.”

UK scrap steel[43]



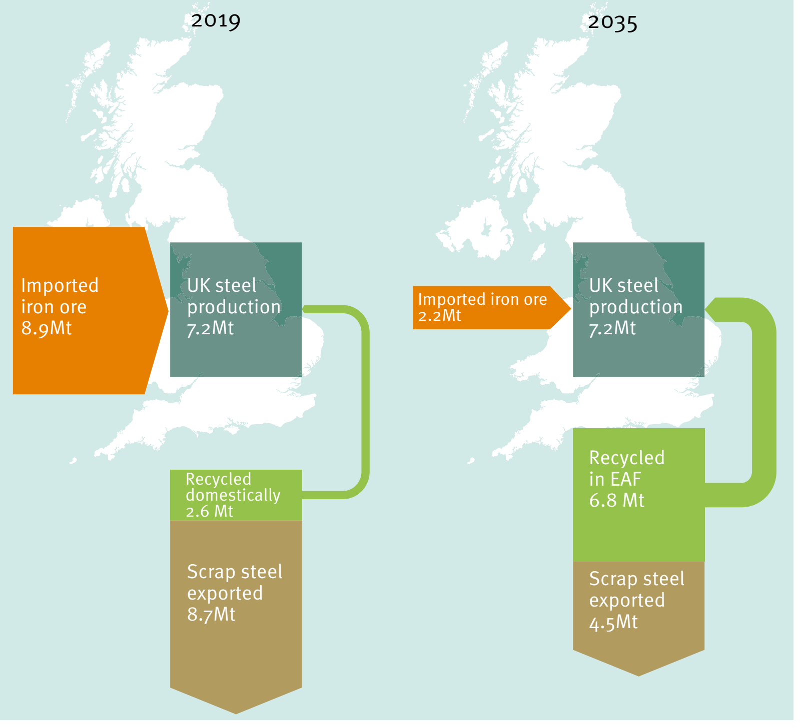
The benefits of being self sufficient

> **Early industrialisation means the UK has large amounts of scrap steel available."**

Early industrialisation means the UK has large amounts of scrap steel available. If it was to follow our recommended pathway for decarbonisation (see page 16), it would reduce its iron ore import requirements by 76 per cent by 2035 and cut its dependence on coking coal by 98 per cent.

This would make the economy less vulnerable to global supply chain shocks and would retain a useful commodity in the UK, rather that exporting poor quality scrap steel to countries like Turkey, then buying it back again at higher prices as finished products.

Potential to increase UK self sufficiency in steel supply chains by 2035[44]



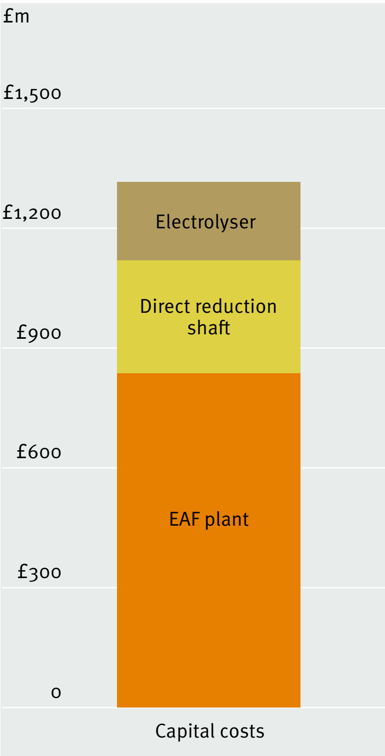
Creating the conditions to support the replacement of existing blast furnaces with EAFs and, eventually, hydrogen production, could bring in capital investment worth around £1.3 billion (see below). It would also increase the stagnating productivity of the sector by an estimated 85 per cent by 2035, based on average labour inputs for EAF and BF-BOF production facilities.[45]

> **"There could be a net increase in steel industry jobs created through the shift to low carbon."**

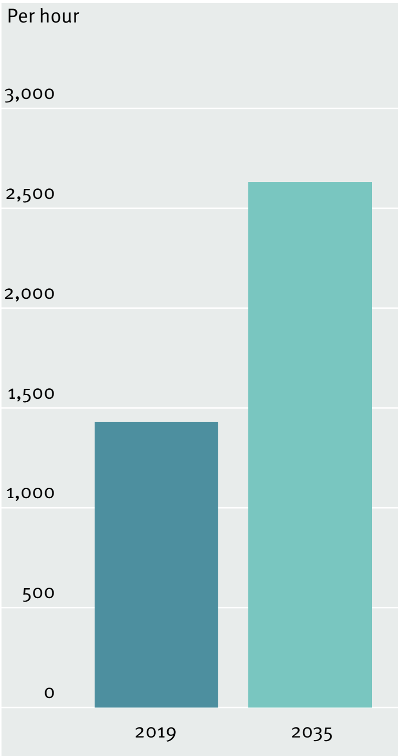
Finally, while EAFs require fewer direct production employees, the impact of this can be minimised with site based transition plans and by expanding scrap steel processing around steel plants. Indeed, based on current labour volumes in the scrap collection and processing sector, there could be a net increase in steel industry jobs created through the shift to low carbon steelmaking.

The economics of steel sector decarbonisation by 2035

Private capital investment[46]



Productivity[47]



Decarbonising primary steel production

> **There is an argument for the UK to develop low emission primary steelmaking ahead of competitors.”**

Despite the promise of electrification, it will probably continue to be difficult to produce a small range of products from scrap, so there is likely to be value in retaining a level of primary steelmaking.[48] In addition, with insufficient scrap steel on the global market to meet total expected demand by 2050, there is an argument for the UK to develop low emission primary steelmaking ahead of competitors.[49]

Both hydrogen and carbon capture and storage (CCS) for steelmaking (where emissions are captured from a BF-BOF plant and stored underground) are still in their infancy, but the former appears to offer a more desirable long term solution for low carbon primary steelmaking, on the basis of the variables we outline on page 13. Additionally, hydrogen is potentially less reliant on infrastructure being developed by third parties, fits better with expanded renewables capacity and EAF production, and is projected to come down in cost as green hydrogen technologies mature.[50,51,52]

Fitting existing blast furnaces with CCS technology, by contrast, risks locking in ageing infrastructure, and will maintain reliance on coal imports.[53] It will also incur high ongoing operational costs that are unlikely to decrease over time.[54] However, if CCS could be deployed earlier than 2030, as is currently projected, then it could cut emissions at scale more rapidly than hydrogen based production. Therefore, it should not be ruled out yet.

Nonetheless, in Europe, hydrogen has become established as the long term future choice for steelmakers.[55] The HYBRIT project in Sweden, supported by the EU Innovation Fund and with Swedish government backing, leads the way and is likely to produce low carbon steel at a commercial scale by 2026.[56] Other major European steelmakers have also committed to hydrogen production, including in France, Germany and Spain.[57,58,59] Without swift action, the UK risks being left behind in this emerging market and might end up importing hydrogen-reduced iron to supply its EAF facilities if it wants to benefit from this option.

If the UK wants to build hydrogen production plants at commercial scale by the early 2030s, which is necessary for it to play a role in meeting a 2035 target, trials need to begin as soon as possible.

"To build hydrogen production plants at commercial scale by the early 2030s, trials need to begin as soon as possible."

Green Alliance and the Materials Processing Institute have previously suggested this could be done in a light touch way to begin with, providing learning for the UK industry as a whole, with £1.3 million exploratory funding and a £10.65 million pilot, before moving on to a £140 million demonstration stage with an EAF. The total bill could be more than covered by the £250 million Clean Steel Fund, announced in 2019, that is supposed to be available from 2023.

Using hydrogen for steelmaking or other processes downstream will require the government to continue developing measures that ensure that the 10GW hydrogen capacity target for 2030 is achieved.

A ‘green power pool’ to cut industrial electricity prices

> **“Reduced generating costs of new renewables have no impact on the underlying wholesale price because of marginal pricing.”**

Prices in the electricity market are set on a marginal pricing basis, whereby the generator with the highest marginal price (operating cost of production) determines the overall wholesale price. As renewables have low operating costs, and as coal is going offline, it is the cost of gas generation that largely sets the wholesale price in the UK. Soaring global gas prices have increased the wholesale electricity price from an average of £35 per MWh in 2020 to £175 per MWh in April 2022.[60]

Contracts for difference (CfD) are used to guarantee renewable energy generators a fixed income, regardless of the market price. They have helped to bring the cost of new offshore wind generation down, from £140 per MWh in 2013 to predictions of £50 in the upcoming 2022 CfD auctions.[61,62] New onshore wind and solar are even cheaper.[63]

These savings have meant that what started out as a levy on consumers to pay for the CfD has become a rebate. However, the reduced generating costs of new renewables have no impact on the underlying wholesale price because of marginal pricing.

Gas and electricity prices are not expected to drop to their previous low levels anytime soon.[64] The government is considering reforms to the electricity market via its upcoming Review of Electricity Market Arrangements, but the scope of this is not yet clear and it may take years to complete.

In the meantime, we propose that a government backed ‘green power pool’ (GPP), originally suggested by academics at UCL, should be introduced within the next two years (see page 27 for an illustration of how this could work).[65] This would enable steelmakers, and possibly a wider group of energy intensive industries, to demonstrate that cheaper electricity would have a transformative effect on their emissions and to access renewable electricity at prices far closer to CfD strike prices, through a mechanism similar to a centrally managed and bundled power purchase agreement.

There are wider benefits from ringfencing a small share of total UK renewables capacity for clean steel production. These are:

> **"A green power pool could reward demand flexibility from steelmakers."**

Demand flexibility

A GPP could reward demand flexibility from steelmakers, with lower costs when the wind is blowing. This would reduce the need for expensive back up generation, providing a wider societal benefit. As EAFs are well suited to this kind of production, compared to blast furnaces, it would be a further incentive to electrify.

Supporting onshore wind development

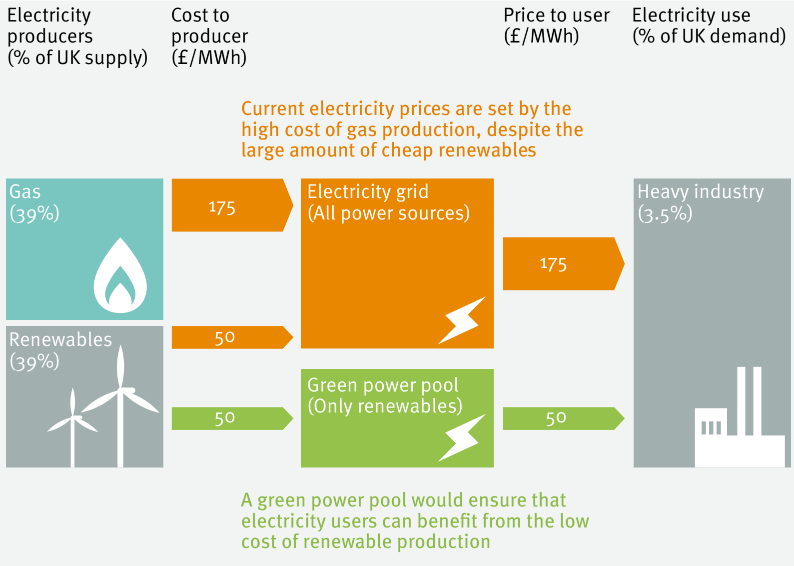
Rather than reassigning existing renewables capacity, a GPP could be used to finance additional onshore wind generation that would not otherwise be developed without a connection to the steel industry. Although onshore wind is one of the cheapest sources of power in the UK, ministers have been reluctant to promote it due to fears about local acceptability. For communities near industrial towns, there is a tangible local benefit: a new onshore wind farm with a GPP would improve the long term prospects of local jobs. A GPP could also be used to help finance the 10.3GW of onshore wind and solar that have planning approval but may continue to be restricted in their access to CfD auctions.[66]

A low risk trial

A GPP, introduced as a time limited scheme for strategic industries, could be used to trial wider electricity market reforms, including a similar power pool for fuel poor households. Even accounting for expansion of electricity demand, in the transition we have outlined, steelmaking will use less than two per cent of UK electricity over the next decade, making it a low risk trial, while being large enough to learn system-wide lessons.

> A comparable power pool has insulated French industry from energy price shocks.”

How a green power pool would work[67]



Competitive edge

In France, a comparable power pool was formed in 2007 when a large industrial consortium called Exeltium negotiated a 24 year contract with EDF to directly access nuclear power at prices between €37-40 per MWh.[68,69] This has insulated French industry from energy price shocks and given it a competitive advantage. Germany has also moved more policy costs away from important industrial uses than the UK. These were deliberate political decisions to gain societal benefits from retaining domestic industry.

A GPP could specifically help the UK steel industry by:

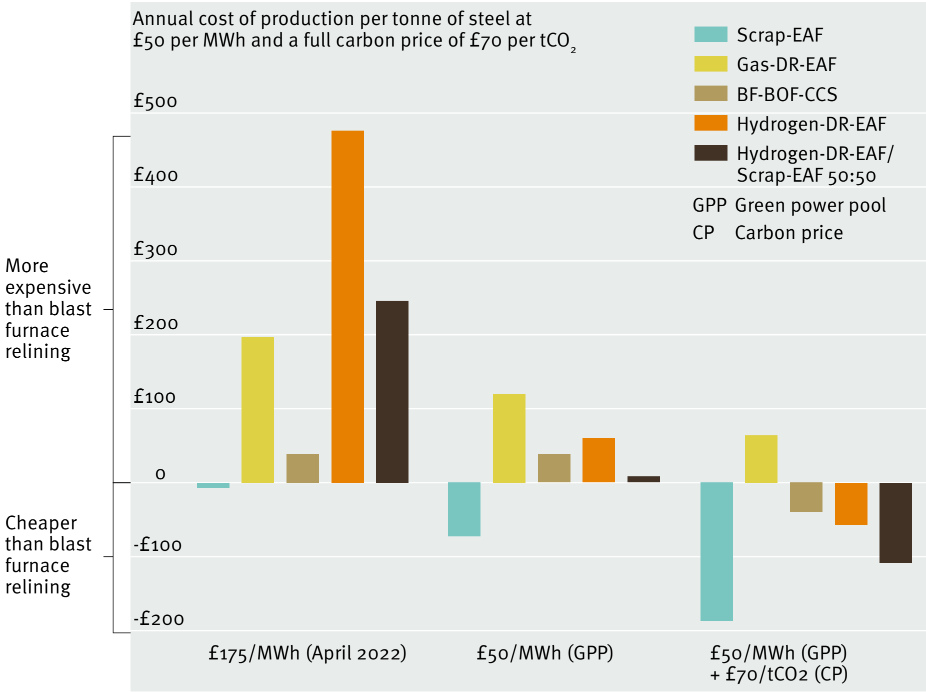
- increasing the predictability of operational costs, especially for heavily electrified processes;
- enabling the government to take on some contract risk, based on the assumption that there will be other buyers for the same power;
- providing another route to capitalise on the flexibility of EAF production processes, in addition to more administratively burdensome and complex options, such as the capacity market.
- more competitive electricity prices, compared to European steelmakers.

These advantages should provide a more compelling environment to invest in UK steel, especially in electrification. This would help to further balance out a policy landscape in which support for CCS is already being developed, along with a mechanism to level out the costs of hydrogen and natural gas.

> **"A green power pool would make investing in clean steel technologies a sound economic choice."**

As the illustration below shows, a GPP offering electricity at £50 per MWh would improve the attractiveness of steel decarbonisation and make Scrap-EAF investment a more sound financial choice, compared to relining an existing blast furnace. Hydrogen steelmaking also becomes significantly more attractive via the GPP and, when combined with 50 per cent scrap based production, it would be close to price parity with the status quo. Additionally, eliminating free allocations in the UK Emissions Trading System (ETS), which could occur by 2030, makes primary hydrogen steel production, based solely on iron ore inputs, cost effective against blast furnace relining.

The effect of a green power pool on different technologies, relative to blast furnace relining



Aligning the scrap and steel sectors

> **"The market for high quality scrap steel is likely to expand."**

Scrap steel is a critical feedstock in low carbon steelmaking processes and UK steel producers could use much more of it. However, the market encourages the export of low quality scrap, rather than processing it to a higher quality for domestic use.[70]

Improving the processing capabilities of the scrap steel sector would have long term advantages. The market for higher quality scrap steel is likely to expand as producers abroad demand inputs for EAF production and wider product ranges.

But the traditional scrap sector could also end up being bypassed by steel producers, who may look for alternative sources of high quality scrap, such as from manufacturing offcuts, which are already used for some high end EAF produced steels. Other predictable sources of scrap steel could include rail repairs and wind farm upgrades, where the outputs could be recycled into the same applications.

These challenges could be addressed with three measures:

VAT exemptions

VAT on scrap steel sold in the UK could be dropped to align the domestic market with export markets like Turkey which charge no VAT.[71]

Capital allowances

The existing super-deduction for plant and machinery investments could be continued beyond 2023 for equipment related to scrap processing.[72]

Minimum quality standards

Minimum quality standards, agreed with the British Metals Recycling Association and the steel industry, could be set for exported scrap steel equivalent to those applied to domestic scrap.[73]

"Minimum quality standards could be set for exported scrap steel equivalent to those applied to domestic scrap."

These solutions should be negotiated with scrap producers and the steel industry together to ensure a mutually reinforcing relationship, whereby steel producers depend on the scrap sector to offer high quality scrap steel, while the scrap sector benefits from a reliable domestic market.

Protecting UK steel production in a global market

> **“Lower emission steelmakers effectively pay a higher carbon price than blast furnace producers.”**

Arrangements for carbon pricing, via the UK ETS and the UK Carbon Price Support scheme (a top up applied to the electricity sector and passed through to steel plants in their electricity prices), present both risks and opportunities for steel sector decarbonisation.

At the highest level, these schemes reward investments in carbon intensive production by cutting compliance costs. But free allocation of carbon credits, introduced to ensure carbon intensive and trade exposed sectors are not uncompetitive internationally due to carbon pricing, removes much of the incentive for action.

Free carbon allowances are also issued unevenly between low carbon steelmaking technologies and blast furnaces. Rather than comparing all similar steel products, regardless of production method, when determining the benchmark level for free allocation, BF-BOF plants are treated separately to EAF plants and some other lower carbon solutions, such as pelletised iron ore inputs. This means lower emission steelmakers effectively pay a higher carbon price per tonne of emissions than blast furnace producers.[74] Reforms of the UK ETS are underway but improvements to these free allocation rules could take some time.

Reforms in this area could also be hastened by the introduction of a carbon border adjustment mechanism (CBAM) or equivalent border product standards for the UK. A CBAM would place a carbon price tariff on goods imported to the UK, ensuring a level playing field for domestic and imported steel goods. Import product standards would do the same by specifying the maximum embedded emissions allowable for steel products, thus restricting the import of steel produced with high carbon processes.

As both of these approaches limit the risk of carbon leakage, they would allow free allocations in the UK ETS to be removed much more rapidly than would otherwise be feasible without hindering domestic competitiveness.

Furthermore, if revenues from the UK ETS and CBAM were routinely fed back into support for industrial decarbonisation, it would help to speed up the transition.[75]

> **"Carbon pricing alone will not deliver industrial decarbonisation in steel or any other sector."**

However, carbon pricing alone will not deliver industrial decarbonisation in steel or any other sector. The 2021 *Industrial decarbonisation strategy* set out a relatively comprehensive policy landscape, including: R&D support; funding for energy efficiency and fuel switching; policies to transfer workforce skills; development of CCS and hydrogen infrastructure; and the development of low carbon, resource efficient product markets.

It is important that all these elements of the strategy are retained and that progress on newer options, like low carbon markets, is accelerated, alongside sector specific actions.

A resilient, low carbon future for steel

"There should be a target of at least 85 per cent reduction in emissions below 2019 levels by 2035."

Although individual companies have decarbonisation plans and are at different stages of lowering emissions, the sector as a whole has not yet set out its vision for the future.

There was a commitment in the *Industrial decarbonisation strategy* to consider a clear target for steel decarbonisation. But more than a year on, industry and government representatives on the Steel Council are yet to announce an agreement or path forward.

The government should break this logjam with a new plan for the steel industry. A clear policy framework should be set out, in exchange for guaranteed action from the industry.

Besides action on issues like electricity prices, the scrap steel market and carbon pricing, there should be a timeline for decarbonisation, with a target of at least 85 per cent reduction in emissions below 2019 levels by 2035. Similar deals have been reached for the wind industry and North Sea oil and gas and, at a much more modest scale, under the long running series of sectoral Climate Change Agreements.[76,77]

By taking these steps, the government and the industry can ensure a resilient and low carbon future for UK steel that enables, rather than hinders, ambitions to level up the country and achieve a net zero carbon economy.

Endnotes

1 Tata Steel, 2020, *Tata Steel in the UK*

2 D Kinch, 25 September 2020, 'British Steel 'fully operational', to launch new products for UK infrastructure drive', S&P Global

3 British Steel, 2022, 'Hinkley Point C'

4 Department for Business, Energy and Industrial Strategy (BEIS), 2021, *Industrial decarbonisation strategy*

5 S Yu, J Lehne, N Blahut and M Charles, 2021, *Decarbonising the steel sector in Paris compatible pathways*, E3G

6 UK Steel, 2021, *Key statistics guide April 2021*

7 UK Steel, 2021, *A barrier to decarbonisation: industrial electricity prices faced by UK steelmakers*

8 M Azevedo et al, 10 January 2022, 'The raw-materials challenge: how the metals and mining sector will be at the core of enabling the energy transition', McKinsey & Company

9 YouGov, 2021, YouGov and Green Alliance survey results

10 The Climate Group, 2022, 'Steelzero members'

11 J Hill, 12 April 2021, 'Volvo to start using fossil-free green steel in cars from this year', *The Driven*

12 The White House, 31 October 2021, 'Joint US-EU statement on trade in steel and aluminum'

13 European Commission, 2021, 'Carbon Border Adjustment Mechanism'

14 UK Steel, 2021, op cit

15 BEIS, 2021, *Net zero strategy: build back greener*

16 H Edwardes-Evans, 9 November 2021, 'COP26: Five developed nations commit to support low carbon steel, cement sectors', SP Global

17 Prime Minister's Office, 10 Downing Street, 2 November 2021, 'World leaders join UK's Glasgow Breakthroughs to speed up affordable clean tech worldwide'

18 BEIS, 2017, *Future capacities and capabilities of the UK steel industry: summary report*

19 BEIS, 2021, *Industrial decarbonisation strategy*

20 Ember, 2020, *UK steel production dataset 2020*

21 Ibid

22 R Tate, 2022, *Bigger than oil or gas? Sizing up coal mine methane,* Global Energy Monitor

23 R Hall, W Zhuang and Z Li, 2021, *Domestic scrap steel recycling – economic, environmental and social opportunities,* University of Warwick

24 For sources, see methodology at green-alliance.org.uk/wp-content/uploads/2022/07/Building-the-future-methodology.pdf

25 Ember, op cit

26 For sources, see methodology at green-alliance.org.uk/wp-content/uploads/2022/07/Building-the-future-methodology.pdf

27 S Farrell, D Smith, 28 September 2015, 'Redcar steel plant to close with 1,700 job losses', *The Guardian*

28 Statista, 6 May 2022, 'Leading supplier of coking coal to the United Kingdom (UK) from 2002 to 2020'

29 S Brown, 21 September 2021, 'Fossil gas costs drive UK electricity price increases', Ember

30 V Srivastava and M Campbell, 2021, *Research into GB electricity prices for energy intensive industries,* Ofgem

31 BEIS, 2022, *British energy security strategy*

32 R Willis, M Berners-Lee, R Watson and M Elm, 2020, *The case against new coal mines in the UK*, Green Alliance

33 A Thomson, 20 May 2022, 'Exclusive: British steel industry leaders do not require coal from proposed Cumbria mine', Channel 4

34 For sources see methodology at green-alliance.org.uk/wp-content/uploads/2022/07/Building-the-future-methodology.pdf

35 The exact volume of virgin steel production required in UK by 2035 to meet demand is not clear for technological and market reasons. However, if more primary capacity than the estimated 20 per cent (of 7.2Mt) is needed there is potential for importing limited amounts of direct reduced iron (DRI).

36 J Allwood, 2022, 'Cambridge electric cement: zero-emissions cement from old concrete paste replacing flux in electric-arc furnaces', EPSRC

37 Luxmet, 19 January 2022, 'Reducing electrode wear in EAF steelmaking'

38 T Echterhof, 2021, 'Review on the use of alternative carbon sources in EAF steelmaking', *Metals*

39 EU Commission, 2013, *Sustainable EAF steel production (GREENEAF)*

40 Climate Change Committee (CCC), 2020, *The sixth carbon budget*

41 World Steel, 2020, *Steel statistical yearbook 2020 concise version*

42 BEIS, 2021, 'International industrial energy prices'

43 For sources, see methodology at green-alliance.org.uk/wp-content/uploads/2022/07/Building-the-future-methodology.pdf

44 Ibid

45 C McDonald, S Portet, M Spatari, 2021, *Decarbonisation of the steel industry in the UK: toward a mutualised green solution,* Materials Processing Institute

46 For sources, please see methodology at green-alliance.org.uk/wp-content/uploads/2022/07/Building-the-future-methodology.pdf

47 Ibid

48 C McDonald, 2021, op cit

49 Net Zero Steel, 2021, *The net-zero steel pathway methodology project: final report and recommendations*

50 C McDonald, 2021, op cit

51 L James, 6 May 2021, 'Offshore wind – exploring the advent of green hydrogen power', Burges Salmon

52 E Taibi, H Blanco, R Miranda and M Carmo, 2020, *Green hydrogen cost reduction: scaling up electrolysers to meet the 1.5°C climate goal,* International Renewable Energy Agency

53 N Earl, 13 March 2022, 'UK steel firms suspend imports of Russian coal', *City AM*

54 Element Energy, 2013, *The costs of CCS for UK industry – a high level review*

55 Bellona, 26 May 2021, 'Hydrogen in steel production: what is happening in Europe – part two'

56 SSAB, 1 April 2022, 'HYBRIT receives support from the EU innovation fund'

57 ArcelorMittal, 13 July 2021, 'ArcelorMittal signs MoU with the Spanish government supporting €1 billion investment in decarbonisation technologies'

58 ArcelorMittal, 7 September 2021, 'German Federal Government commits its intention to provide €55 million of funding for ArcelorMittal's Hydrogen DRI plant

59 ArcelorMittal, 4 February 2022, 'ArcelorMittal accelerates its decarbonisation with a €1.7 billion investment programme in France, supported by the French Government'

60 Nordpool Group, 2022, 'N2EX day ahead auction prices'

61 S Evans, 16 February 2022, 'Gas generation in Feb 2022 is around four times more expensive to run than new solar or windfarms', twitter.com/DrSimEvans/status/1493906931739680768

62 BEIS, 11 October 2019, 'Contracts for Difference (CfD) allocation round 3: results'

63 S Evans, 2022, op cit

64 S Johnston, 2022, *GB Power Market Outlook to 2030,* Cornwall Insight

65 M Grubb and P Drummond, 2018, *UK industrial electricity prices: competitiveness in a low carbon world,* University College London

66 P Waugh, 9 March 2022, 'Why onshore wind, not fracking, offers Boris Johnson a better weapon against Vladimir Putin', *inews*

67 For sources, please see methodology at green-alliance.org.uk/wp-content/uploads/2022/07/Building-the-future-methodology.pdf

68 P Drummond, M Grubb and E Barazza, 2021, *Delivering competitive industrial electricity prices in an era of transition,* Aldersgate Group

69 Clarion Energy, 17 January 2007, 'French EDF, big power users Exeltium sign MoU on long-term tariff', *Power Engineering*

70 R Hall et al, 2021, op cit

71 Ibid

72 HMRC, 3 March 2021, 'New temporary tax reliefs on qualifying capital asset investments from 1 April 2021'

73 L Whitham, A Musat and N Molho, 2022, *The missing link: establishing strong UK supply chains for low carbon industrial products*

74 J Allwood, C Dunant, R Lupton and A Cabrera Serrenho, 2019, *Steel arising: opportunities for the UK in a transforming global steel industry,* University of Cambridge

75 L Whitham et al, 2022, op cit

76 BEIS, 2022, *North sea transition deal*

77 Environment Agency, 2022, *Climate change agreements*

Erratum

We revised some figures cited in this report following publication: in the illustration on page 11, the emissions values for Scrap-EAF and BF-BOF were updated to reflect a more accurate data source; the illustrations on page 22 and 28 were updated to reflect a more up to date EUR:GBP exchange rate; in the illustration 'How a green power pool would work' on page 27, the gas 'cost to producer' and the electricity grid 'price to user' were corrected to £175 (from £250). See the methodology online at green-alliance.org.uk/wp-content/uploads/2022/07/Building-the-future-methodology.pdf for the data source and exchange rate used.

Green Alliance
18th Floor
Millbank Tower
21-24 Millbank
London SW1P 4QP

020 7233 7433
ga@green-alliance.org.uk

www.green-alliance.org.uk
@GreenAllianceUK
blog: www.greenallianceblog.org.uk