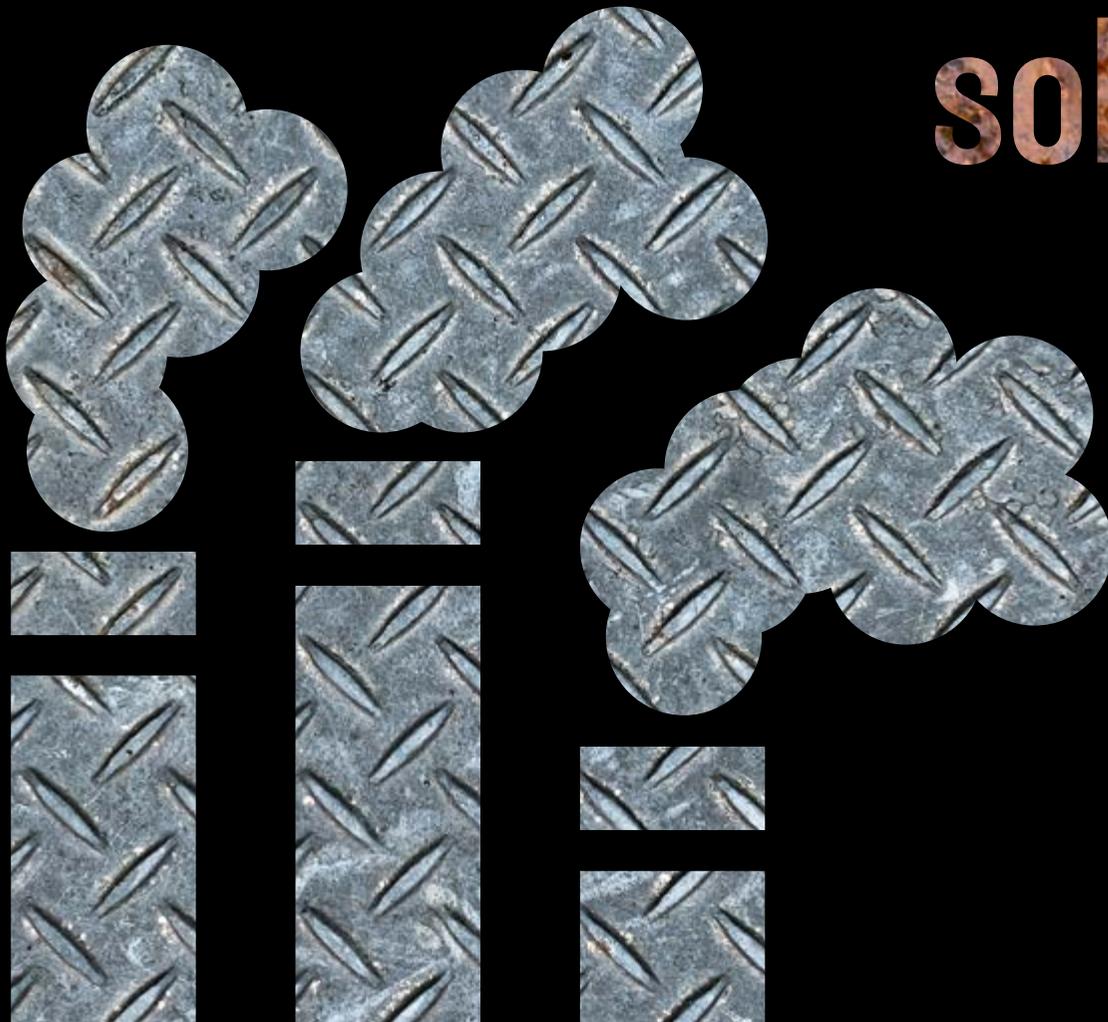


COAL
ACTION
NETWORK

Coal in steel

Problems and solutions





September 2021
Version 2

“ We hope this report catalyses conversations and further research. It is important that we consider it may be necessary to make radical changes to the way in which we live, work, and travel to reduce our need for steel and consumable goods. ”

 [@CoalActionUK](https://twitter.com/CoalActionUK) info@coalaction.org.uk www.coalaction.org.uk

Coal Action Network works for an end to coal-fired power generation, coal extraction and coal imports in the UK, and for justice for communities affected by the UK's current and historical coal consumption and mining.

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Summary

We are facing a climate emergency. This reality is underlined every day by extreme weather and 'natural disasters'. The steel industry produces 11% of the annual CO₂ emitted globally, contributing significantly to climate change.¹ This is largely due to the reliance on coking coal in primary steel production.

The UK government is to decide whether West Cumbria Mining Ltd can start a new large underground coking coal mine, called Woodhouse Colliery, in West Cumbria. West Cumbria Mining Ltd plan to export coking coal to European steelworks which would worsen climate change. The planning application will be decided following a Public Inquiry in Autumn 2021.

All aspects of the steel industry are globalised, including the coking coal inputs, iron ore, finished products, scrap steel, and the emissions produced. The impacts of these emissions are experienced internationally and the rest are traded globally. Solutions to decarbonise steel, therefore, must cross national borders with answers needed everywhere—so we should start taking action wherever we are based. The UK government intends to decarbonise steel by 2035, giving steel companies a central role in reducing emissions and changing the accepted standards of steel production and resource use.

In the UK, Port Talbot and Scunthorpe Steelworks are the second and third biggest single site emitters of carbon.² Both sites use the broadly two stage 'blast furnaces – basic oxygen furnaces' with metallurgical coal to make virgin steel. The other two large steel producers – Liberty Steel and Celsa recycle scrap steel in 'electric arc furnaces' which reduces the climate impact of those steel products.

Four of the five biggest global steel producers aim to reach carbon neutral steel production by 2050. To keep up, the UK's steelworks need to decarbonise as well. If not, customers aiming to reach their own climate goals will likely choose to import lower carbon steel from other European countries like Sweden and Spain who are pursuing low-emissions steelmaking projects.

Decarbonisation of the steel sector could be achieved through:

- increased use of electric arc furnaces and recycled scrap—already happening in the UK.
- using direct reduced iron production with green hydrogen in place of coke (which is produced from metallurgical coal). The HYBRIT project aims to do this at a commercial scale in Sweden by 2026, having made their first delivery of fossil free steel in August 2021.³
- reducing steel consumption through more efficient design of buildings, cars, energy infrastructure, and consumer products. Promoted by *The Use Less Group* at Cambridge University.

Section 1

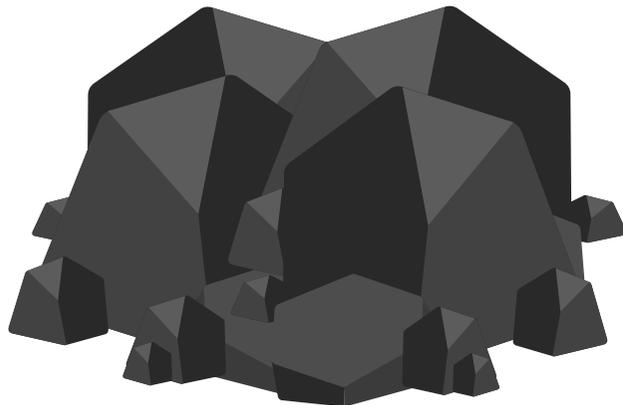
Introduction

None of these solutions alone can make the big changes needed in this sector to address emissions, but they can in combination.

The increased use of scrap steel in electric arc furnaces is being considered at Port Talbot and could prevent this large employer in South Wales from closing entirely.

It is easy to feel powerless when faced with climate change and big industries like steel. However, through fighting against the proposed new coal mines in the UK and supporting communities working to the same end in other countries we can make a real change.

Campaigns to reduce emissions in the UK from steel, as well as at other sources, is part of a vital and energetic international movement for a more sustainable world - where our need for employment does not have to compete with our requirement for fresh air, clean water, and viable communities. To stand in solidarity with people at the forefront of climate change and resource extraction we need to overcome the barriers to our societies decarbonising.



That we are facing a climate emergency is underlined every day by increasing extreme weather events. 11% of the annual CO₂ emitted globally is produced by the steel industry, this needs to be reduced.⁴ This is an entirely global industry, trading in coal inputs, iron ore, end products, and scrap steel. When coal is involved, it creates a global problem through carbon emissions.

In the UK, two of the three biggest single site emitters of CO₂ are Tata Steel's Port Talbot steelworks and British Steel's Scunthorpe steelworks.⁵ This is largely because both sites use metallurgical coal in the steelmaking process, rather than lower-emission steel production methods.

Steel is the world's most recycled material.⁶ It is used extensively in construction, cars, wind turbines, and in many other applications. The steel industry is increasingly facing scrutiny over its need to reduce emissions. Several major global steel companies have carbon neutral pledges, so are now researching decarbonisation options and several have built test facilities. Urgent government support and action is needed to enable the steel industry to reduce the emissions

through the elimination of coal from production processes and to provide green energy where hydrogen is used.

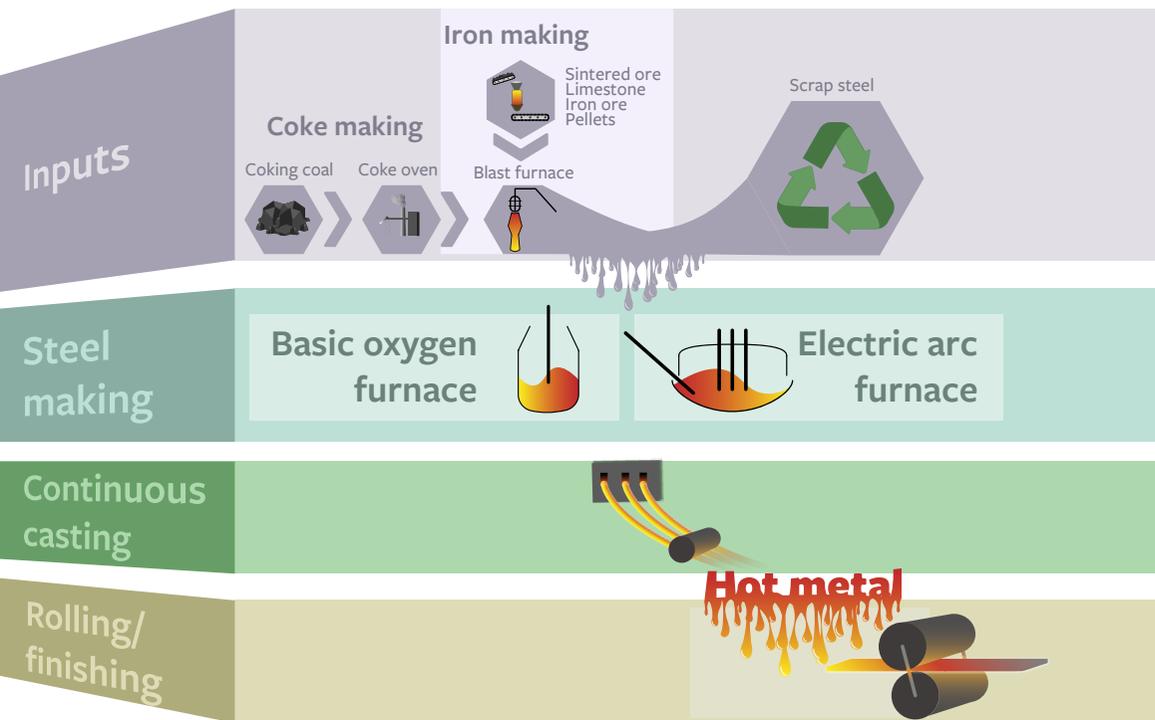
In 2019, the UK Government enshrined in law a commitment to be carbon-neutral by 2050, but there are two applications for new coking coal mines to supply European steelworks up to 2049, and potentially up to 2070, being considered. For the first – Woodhouse Colliery – there is a public inquiry scheduled for September 2021. The government will then decide whether this new underground coking coal mine, near Whitehaven in Cumbria, proposed by West Cumbria Mining Ltd, can go ahead. The question of whether coal can be replaced with greener alternatives to make steel has to be answered, if we are to keep

coal underground for the sake of the local environment and to tackle climate change.

The International Energy Agency expects steel production to increase by 30% by 2050. This is encouraging coal companies to apply for long-term coking coal mining projects to feed that predicted rise in steel production. The forecast is very different for thermal coal use in power stations, as this is increasingly seen as contributing unacceptably to climate change. Consequently, big mining companies such as BHP are looking to exit thermal coal mining, but keeping mines producing coal for steel.⁷ This must change.

Coal in steel is aimed at individuals looking for background information to the campaigns against the proposed new coking coal mines and considering how coal needs to be phased out of steel production. The report counters the positions of companies arguing an ongoing need for coking coal in the steel industry. *Coal in Steel* is UK focused, but the coking coal mines proposed would export coal, potentially to Europe.

Coal in steel looks at the impacts from the use of coal in steel manufacturing on carbon emissions; considers the current and possible lower carbon steel production methods; the social and ecological impacts of mining the raw materials; why new coking coal mines are a step in the wrong direction; and how change is possible.



Section 2

Coal in steel

Steelmaking processes

Primary steelmaking (aka steel made from raw materials) is a two stage process, first the raw materials are made into iron and then they are processed into steel.

The two main routes for iron making are:

1. Blast furnaces which make pig iron (aka crude iron); and
2. Direct reduced iron plants which make direct reduced iron (DRI), which is also known as sponge iron.

The two main routes for steelmaking are:

1. Basic oxygen furnaces which turn crude iron into steel; and
2. Electric arc furnaces which turn sponge iron and/or scrap steel into steel.

Secondary steelmaking (aka steel made from recycled scrap) is a single stage process in which scrap steel is remelted in an electric arc furnace.

Therefore, the three main steelmaking processes are:

1) Blast furnace – basic oxygen furnace (BF-BOF) steel production where metallurgical coal is converted into coke - an ingredient in the chemical reaction used to produce steel. Thus, our ability to decarbonize the BF-BOF steelmaking method is limited by these unavoidable process emissions. (Coal can also be used as an energy source in BF-BOF, but other fuel can be used.) BF-BOF methods produce 75% of steel globally,⁸ and it is used at half of the major UK's production sites. The basic techniques used in blast furnaces have barely changed since the 1700s.⁹

2) Direct reduced iron - electric arc furnace (DRI-EAF) steel production. In direct reduced iron (DRI) production, oxygen is removed from iron ore using a reducing agent like elemental carbon (produced from natural gas or metallurgical coal) or a reducing gas like syngas (a mixture of hydrogen and carbon monoxide produced from fossil fuels) or hydrogen (produced from either coal, natural gas, or renewables).¹⁰ In DRI-EAF steel production, scrap steel is normally blended with the DRI to provide 10% of the ore-based product.¹¹ DRI produces about 5% of global steel annually,¹² combined with either electric arc furnace or BF-BOF.

3) Scrap-based electric arc furnace (scrap-EAF) steel production in which steel scrap is remelted in an electric arc furnace to produce new steel products. Recycling scrap in electric arc furnaces is already widely used and does not rely on additional coal consumption¹³. Electric arc furnaces account for 25% of global production.¹⁴

While these production routes represent the most steel making processes, there is some mixing of the different routes. For example, electric arc furnaces fed partially with pig iron from a blast furnace.

What is coking coal?

There are broadly two types of coal found in the UK (a third type, lignite, is not mined or imported here).

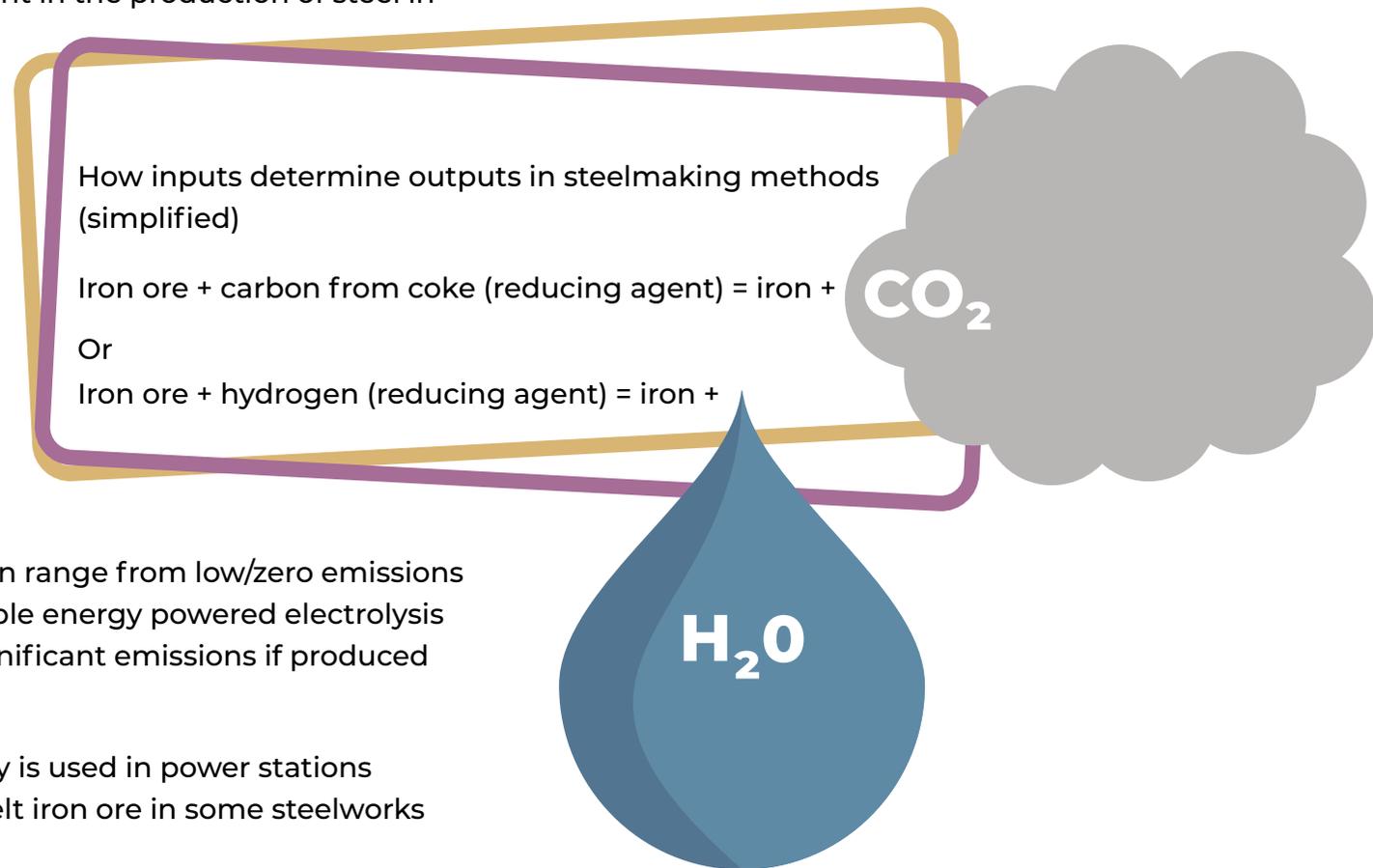
Coking, or metallurgical, coal. Used in the chemical reactions and heating processes in steelworks. It is baked to remove impurities and it turns into coke, which is then consumed. This is the focus of this report.

Coke is used as a reducing agent in the production of steel in blast furnaces. A reducing agent loses an electron to a recipient and is itself oxidised. In steelmaking the recipient is iron ore and the reducing agent is the carbon from coke which combines with oxygen to produce iron plus CO₂. However, if green hydrogen is used as a reducing agent instead, the result would be iron plus harmless water vapour. The production of the hydrogen can range from low/zero emissions if produced with 100% renewable energy powered electrolysis (called green hydrogen), or significant emissions if produced with fossil fuels.

Thermal coal. The vast majority is used in power stations (small amounts are used to melt iron ore in some steelworks

and other industrial processes). It has a high calorific value but fetches a lower price because it is less pure and more common than coking coal. Alternative energy sources to thermal coal are widely implemented, including by steelworks. Coal power stations are closing in many countries due to government policies to reduce climate emissions.

Both coking coal and thermal coal are found in coal seams and the minerals can be extracted at the same sites when both occur together.



UK coal mining

There are two planning applications for underground coking coal mines in the UK. Presently there are no large underground mines operating and no exclusively coking coal mines. Both companies pursuing new coking coal mines say they would primarily supply coking coal for export to Europe. This shows the close relationship between current methods of steel production and continued coking coal mining.

UK coking coal mine proposals

West Cumbria Mining Ltd¹⁵ wants to extract 2.78 million tonnes of coking coal a year until 2070 to supply European and British steelworks. The application to mine at Woodhouse Colliery, Whitehaven, was approved by Cumbria County Council in October 2020 and in January 2021,¹⁶ to allow coal production until 2049.¹⁷

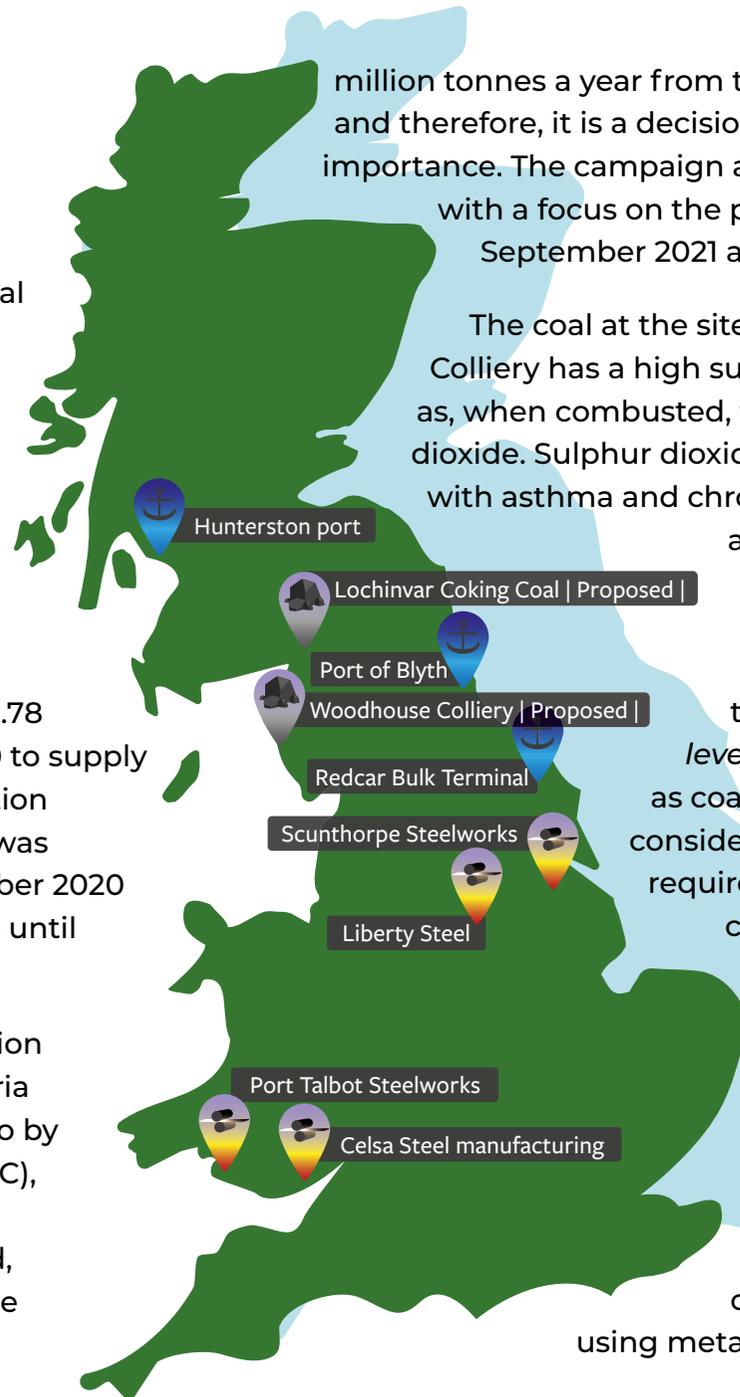
The government has now 'called in' this decision for a public inquiry, taking it out of the Cumbria County Council's hands following calls to do so by South Lakes Action on Climate Change (SLACC), Coal Action Network, and others. SLACC say that the volume of CO₂ that would be emitted, were the mine to go ahead, would exceed nine

million tonnes a year from the consumption of the coal¹⁸ and therefore, it is a decision of national and international importance. The campaign against the application continues with a focus on the public inquiry timetabled for September 2021 and a decision expected in 2022.

The coal at the site of the proposed Woodhouse Colliery has a high sulphur content. This is a problem as, when combusted, the sulphur in coal forms sulphur dioxide. Sulphur dioxide is an acidic gas associated with asthma and chronic bronchitis, as well as forming acid rain.¹⁹ Wardell Armstrong, a consultant to Cumbria County Council, says the most recent planning proposal will likely lead to coal with an "average sulphur level of 1.65%".²⁰ This is significant as coal which is over 1% sulphur is considered high sulphur and therefore requires blending with low sulphur coals, from other sources, to reduce overall sulphur content.²¹

The high sulphur content of the coal could mean that there is a limited, if any, UK market for the coking coal from Woodhouse.

British Steel, who operate the Scunthorpe steelworks, one of the two major UK steelworks using metallurgical coal, have said, "The



*Sulphur content of the coal [from Woodhouse] is an issue for British Steel currently due to our operations and blend sulphur limit” and that coal imported from the USA has lower sulphur content.*²²

In the European market there are sulphur emissions standards relating to steelworks, if the sulphur concentration is too high for these plants then the coal could end up being transported long distances out of Europe and used where the emissions standards are lower.

West Cumbria Mining Ltd is 80% owned by EMR Capital Investment, a private equity manager based in Singapore, which is in turn owned by EMR Capital Resources, a holding company with locations in Australia, Hong Kong, and the Cayman Islands. This is a cause for concern as it means that profits and associated tax, could go to Singapore or to the Cayman Islands where there is no tax.²³

EMR Capital have owned or have had the majority share in 10 mining projects since 2014. The majority of these are not coal mines, but gold, silver, copper, zinc, or potash, often in combination. In June 2021, EMR spun off the three copper mines to a company called 29Metals.²⁴

The private equity fund has a history of buying up projects to start or re-start mining and then selling them again within a few years. If this were to happen with West Cumbria Mining Ltd’s Woodhouse Colliery it could lead to the environmental conditions on the site not being met, poor labour relations and uncertainty for the mine’s future.

New Age Energy (NAE) Ltd, an Australian mining company, have carried out exploratory drilling for coking coal (to estimate how much is there and how accessible it is) across Lochinvar, on the border between England and Scotland. The Lochinvar Coking Coal Project²⁵ aims to supply 1.4 million tonnes per annum to Europe and UK steelworks over 26 years. The company has a conditional licence from the UK coal regulator, but has not yet applied for planning permission, and is likely to be watching the West Cumbria case closely. The coal is also high sulphur, but NAE Ltd say that the coal is within permitted limits. The methods of extraction being considered are underground mining techniques not currently used in the UK – ‘longwall’ and ‘Bord and Pillar’ mining which causes surface level to collapse and lower the surface of the land over the mine. This often disrupts water courses.²⁶ These methods are common in Australia.

Other coal mines

Coking coal seams sometimes lie alongside thermal coal seams (the type of coal used in power stations). The last two existing opencast coal mines in the UK are both in Wales. Ffos-y-fran and Nant Helen produce thermal coal and smaller amounts of coking coal.

There are no opencast coal mines extracting coal in England or Scotland. In 2020, the last three applications for new opencast coal mines in the UK were rejected by local councils or the government following strong local opposition.

Climate change

Primary steel manufacturing in a blast furnace is a highly polluting process. The production of one tonne of steel using coking coal requires 770kg of coal²⁷ and releases two tonnes of CO₂.²⁸ The iron and steel industry is responsible for 11% of global CO₂ emissions.²⁹ In the UK iron and steel account for 12 million tonnes of CO₂ equivalent a year, 15% of the total annual industrial emissions.³⁰

The Department for Business, Energy and Industrial Strategy's Industrial Decarbonisation Strategy notes that the Port Talbot and Scunthorpe steelworks *“alone produced 11 MtCO₂e in 2017, 95% of the total emissions from iron and steel sites and around 15% of total industrial emissions[...] Decarbonising these two blast furnace sites and the wider steel sector will be essential to the decarbonisation story of UK industry.”*³¹

The 2019 amendment to the Climate Change Act (2008) says that the UK must reach carbon net-neutrality by 2050,³² to be in-line with the Paris Agreement's efforts to limit global warming to between 1.5 and 2 degrees.³³ If the UK faced its historic contribution, it would seek to bring this target forward to an earlier date.

Asad Rehman from War on Want describes the problems climate change is causing, *“Warming of just 1°C has been enough to unleash killer floods, droughts and famines. In every corner of the world climate violence has already been exacting a heavy toll on the poorest and most vulnerable. [...] The most conservative estimates are that each year close to*

*a million lives in the global south are already being claimed by the violence of climate change with many more millions losing their homes and livelihoods. The climate crisis also fans the existing flames of economic inequality and poverty, resulting in a deepening crisis of hunger, increased conflict and deepening existing racial and gender inequalities. All of which determine the very ability of people to survive climate impacts and to adapt to, and respond to, the realities of the climate crisis.”*³⁴

Steel production in the UK

UK currently consumes around 15 million tonnes of steel per year,³⁵ half of which is produced here.³⁶ There are four large plants making steel in the UK.^{37,38} Tata Steel, an Indian company, owns Port Talbot steelworks in South Wales and Chinese Jingye Group owns British Steel, the subsidiary that runs Scunthorpe steelworks in Lincolnshire. Both produce steel using coking coal in blast furnaces (with some recycled steel later in the process³⁹). Consequently, these steelworks are two of the three biggest single site emitters of CO₂ in the country.⁴⁰

Tata Steel is investigating converting its Port Talbot steelworks from a BF-BOF to an EAF producing steel from recycled scrap steel, which does not need coal. It has appealed to the government for financial help for this through the Project Birch fund which was set up to help big, strategically important companies crippled by the Covid-19 pandemic.⁴¹

Celsa, in Cardiff, and Liberty Steel, in Rotherham, produce steel from recycled scrap steel, through EAF. Internationally, Liberty

Steel has pledged to become a carbon neutral company by 2030, by stopping using coal and instead increasing scrap steel usage.

In total, the UK creates over 10 million tonnes of scrap steel annually, of which 2.7 million tonnes is recycled by UK steelworks. The rest is exported. There is scope for greater domestic use of this resource.⁴²

Roland Junck, president of Liberty Steel has argued that companies should take the financial leap and invest in electric arc furnaces powered by renewable energy to reduce the impact on climate change. *“The right way is to tackle the problem as early as possible—not to wait to be the last ones”* Junck said.⁴³ There is concern that if British companies do not decarbonise they will be priced out of the market by European steel makers, which are making big promises to reduce emissions, or Asian companies selling high emission steel at a low cost.

Steel workers need to be protected as their industry transitions towards a cleaner future, which must be done with direct consultation with the unions and workers. If the steelworks in the UK fail to decarbonise, there is a real risk that much of this production will be offshored and many workers will lose their employment. UK decarbonisation is necessary to protect employment and the towns that are economically tied to the industry.

Government action on steel emissions

The government has started considering the impacts of the steel industry on climate change, stating: *“This year, [2021] in collaboration with the Steel Council, we will consider the implications of the recommendation of the Climate Change Committee to ‘set targets for ore-based steelmaking to reach near-zero emissions by 2035’ and the business environment necessary to support the transition.”*⁴⁴

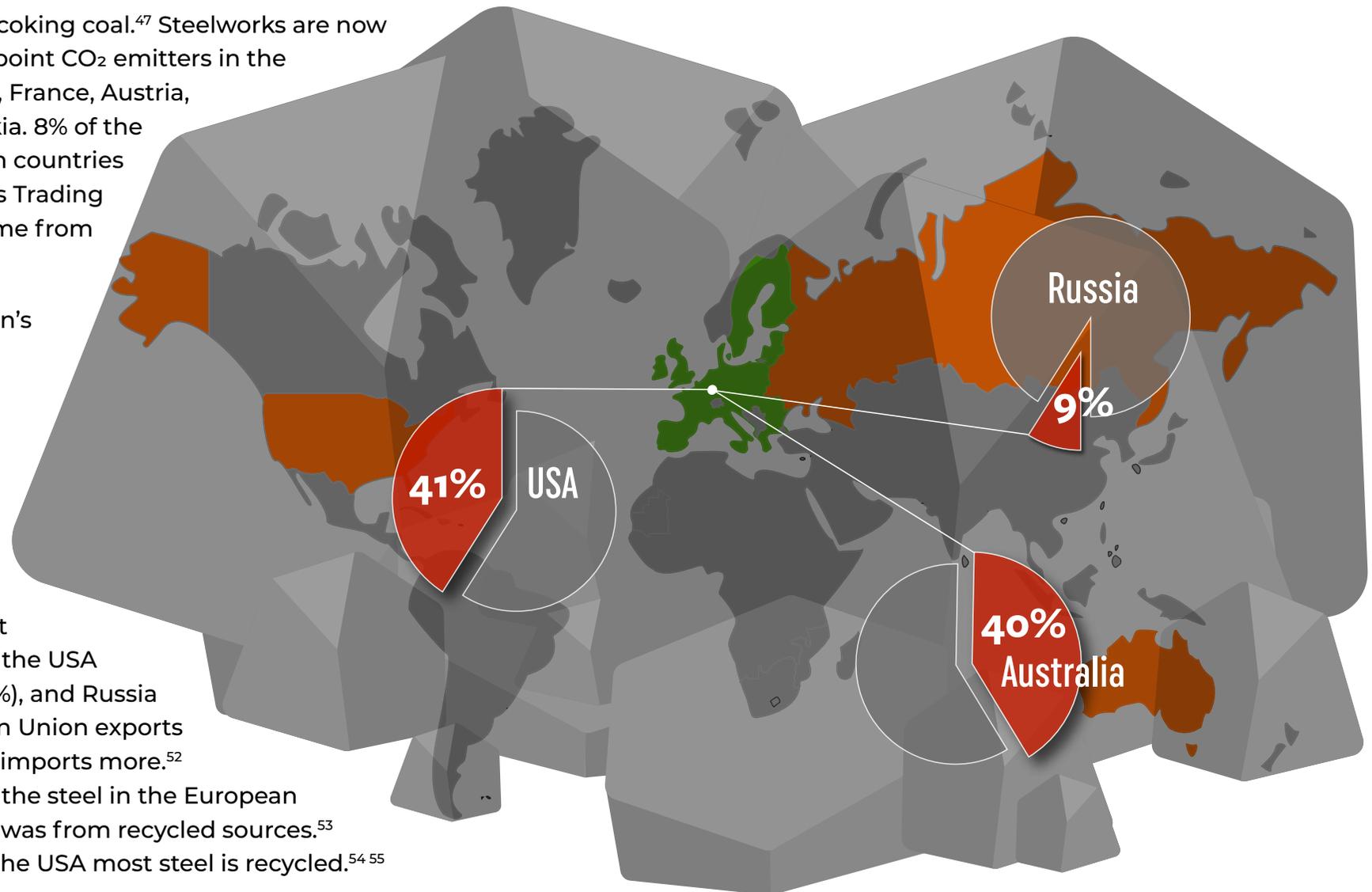
The UK government is administering a £250 million Clean Steel Fund to subsidise companies in the UK steel sector to *“transition to lower carbon iron and steel production through new technologies and processes, placing the sector on a pathway that is consistent with the UK Climate Change Act (net zero)”*. This is to *“maximise longevity and resilience in the UK steel sector by building on long standing expertise and skills and harnessing clean growth opportunities.”*⁴⁵

The government also intends to establish a new £100 million Low Carbon Hydrogen Production Fund, to *“support the deployment of low carbon hydrogen production at scale[...] to lower carbon steel production and support broader efforts to decarbonise industry.”*⁴⁶ The current government’s commitment to removing coal from steel production is not yet consistent, however, as it fails to rule out new coking coal mines at the time of writing.

Steelworks in the European Union—potential markets for UK coking coal mines

In the European Union there are around 500 steelworks most of which use coking coal.⁴⁷ Steelworks are now the biggest single point CO₂ emitters in the Netherlands, Spain, France, Austria, Finland, and Slovakia. 8% of the CO₂ emissions from countries in the EU Emissions Trading Scheme in 2019 came from steelworks.^{48 49}

The European Union's annual demand for coking coal in 2019 was approximately 53 million tonnes, with annual imports of around 40-44 million tonnes mainly from distant countries⁵⁰ such as the USA (41%), Australia (40%), and Russia (9%).⁵¹ The European Union exports 14% of its steel and imports more.⁵² On average 40% of the steel in the European Union used in 2017 was from recycled sources.⁵³ By comparison, in the USA most steel is recycled.^{54 55}



The EU's imports of coking coal in 2019

Section 3

Alternatives to coal in steel

Electric arc furnaces which produce steel by recycling scrap metal are already widely used.

Possible decarbonisation technologies

There are various new technologies being trialled by big steelmaking companies abroad to reduce emissions. Below are the three main methods in development: using green hydrogen as a reduction agent instead of coke; direct reduced iron without hydrogen, and carbon capture (utilisation) and storage. The advantages and disadvantages of these technologies are covered in Section 4. Some European examples from smaller producers are included together with the carbon reduction strategies of the five biggest steel producers globally.

Recycling steel

Electric arc furnaces use scrap steel as the main source of iron. Scrap steel can also be added in with the iron ore in blast furnaces, supplying 15-20% of the iron and around 10% in direct reduction iron production.⁵⁶

Electric arc furnaces are already in use in the UK at Liberty Steel's Rotherham plant and Celsa in Cardiff, as well as at many other sites globally. The process is described earlier in this report.

There is broad scope for the recycling of scrap steel. The Statistics Advisor of the Bureau of International Recycling Ferrous Division, Rolf Willeke, says, "*we calculate that 630 million tonnes of steel scrap are recycled every year, saving nearly 950 million tonnes of annual CO₂ emissions that would have come from the production of virgin steel[...] it should also be highlighted that steel recycling saves energy and conserves natural resources, thus making a decisive contribution to climate protection.*"⁵⁷ The benefits of this method go well beyond reducing carbon emissions.

Currently the UK generates around 10 million tonnes of scrap each year. The scrap steel is mainly exported at present.⁵⁸ Steel recycling produces less CO₂ than primary manufacturing, especially in the UK as the electricity grid has fairly low emissions, partly because coal power generation has decreased dramatically (to just 2.8% of primary energy demand in 2019⁵⁹).

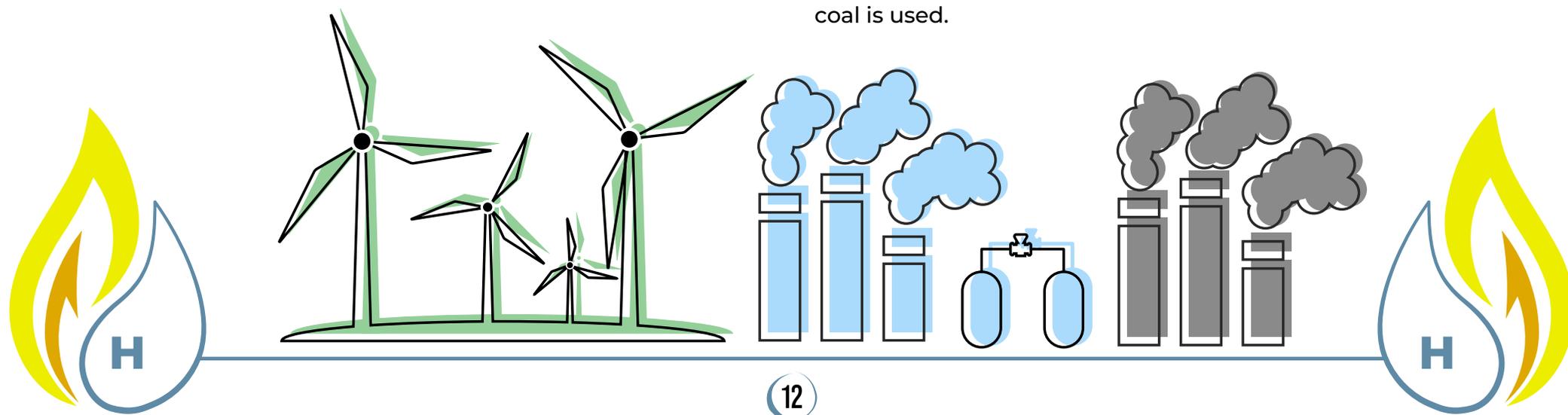
The price of recycled steel can exceed that of primary steel, meaning that companies choose the latter despite the higher CO₂ emissions due to cost considerations.⁶⁰ The availability of scrap steel is expected to increase significantly in the next thirty years, as recycling increases, with the biggest gains to be made in the construction sector. According to the Net Zero report, *“Recycled steel can have the same quality as blast furnace steel. In fact, some of the highest quality aerospace grades of steel used in the UK are made in Rotherham by recycling.”*⁶¹ Of course, even with improvements to the recycling rate for scrap steel, it relies on the continuing production of primary steel, so this is just one piece of the puzzle.

Using hydrogen instead of coking coal

This concept has strong support from many steel companies. Hydrogen is used in place of coke formed from coking coal, to reduce the iron ore into iron and water, rather than iron and polluting CO₂, thus dramatically reducing emissions when the hydrogen production is via renewables.

The main source of potential emissions in this process is through the production of hydrogen as extracting it from compounds requires a lot of energy. The carbon intensity of the steel production is very dependent on how the hydrogen was produced. If steel is made using the direct reduced iron - electric arc furnace route (DRI-EAF), and the hydrogen is produced using renewable energy, it has a very low climate impact and the hydrogen is referred to as ‘green hydrogen’.

Other methods of hydrogen production generate many more emissions. If fossil fuels are used to produce the hydrogen, the emissions are dramatically increased compared to the DRI-EAF green hydrogen method above, but still significantly less than the blast furnace-basic oxygen furnace (BF-BOF) route. If the carbon released from the fossil fuel method is captured using carbon capture and storage (CCS), this is called ‘blue hydrogen’. If CCS worked, then blue hydrogen would be lower in carbon than ‘grey hydrogen’—where the hydrogen is made using fossil fuels and nothing is captured. Making steel using hydrogen uses more electricity than conventional steel production, which can make the cost of the steel product higher than when coking coal is used.



The world's first fossil-free hydrogen-powered steel plant located in Luleå, northern Sweden, began operations at the end of August 2020 and produced its first pilot test amount in June 2021.⁶² The company behind it, HYBRIT (Hydrogen Breakthrough Ironmaking Technology), aims to reduce CO₂ emissions in the steel industry by replacing coking coal with hydrogen in the direct reduction steelmaking process. HYBRIT is a partnership between steel maker SSAB, miner LKAB, and utility company, Vattenfall. The venture will produce commercial-scale fossil-free steel products starting from 2026⁶³, following successfully producing steel for Volvo in August 2021.⁶⁴

Germany's largest steel maker, Thyssenkrupp Steel, is building a steelworks to use 'green' hydrogen, created by renewable energy, to produce direct-reduced iron at its Duisburg steelworks. The steelworks alone currently accounts for 2% of Germany's CO₂ emissions. The plan is part of Thyssenkrupp's efforts to become carbon-neutral by 2050, but this would be hampered if insufficient hydrogen is available, as the company say they would use gas in that scenario.⁶⁵

Direct reduction iron (DRI) without hydrogen

DRI methods are already used globally. DRI does not need to use coking coal, but can instead reduce the iron ore currently using natural gas (although some do use coal).⁶⁶ Statistics on how widely used non-coal DRI methods are is not currently available. Some advocate DRI with natural gas as a temporary solution to reduce emissions as the infrastructure can be switched to green hydrogen when this becomes available at scale.

Carbon capture and storage

A frequently cited way to reduce CO₂ emissions is to capture the CO₂ released at the point of production, for example, on steel mills and hold the carbon indefinitely underground. This is the idea behind Carbon Capture and Storage (CCS).

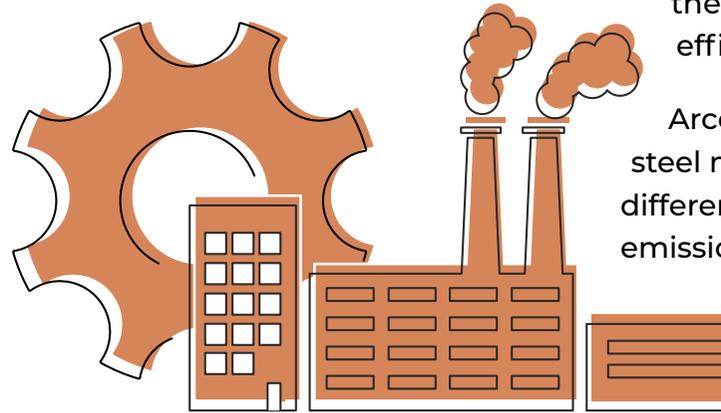
Some companies are developing methods to utilise the carbon once it has been collected. This is called Carbon Capture Utilisation and Storage (CCUS). In the United Arab Emirates, Emirates Steel has already retrofitted a CO₂ capture unit at its Mussafah steelworks. The CO₂ generated in the steelmaking process is piped over 40km to Abu Dhabi National Oil Company's oil fields where it is used to force out additional oil from the depleted oil field. This pipeline is the highest-pressure CO₂ transfer line in the world. This sort of CCUS is called Enhanced Oil Recovery and results in more oil being consumed with its associated carbon impacts.⁶⁷ At present there are about 20 CCUS systems operating globally.⁶⁸

Both CCS and CCUS could enable existing steel mills to continue production as it can be retrofitted to steelworks. However, the carbon and capture process requires large amounts energy to power the process so that must be considered when assessing its benefits.

There is widespread criticism of CC(U)S. CCS is seen as a way to continue with business as usual without really making the necessary changes to reduce our impact on the climate. CCUS projects like the Emirates Steel's do not release figures for how much CO₂ is actually recovered. Other better known CCS projects have not had the results desired by their creators.

Energy giant Chevron's touted world's biggest CCS project has failed to meet a five-year target for burying 80% of the CO₂ from Gorgon liquefied natural gas development, under the island of Barrow, off Western Australia where the plant is located. The project was delayed over three years due to technical set backs, and only 30% of the CO₂ expected to be deposited has been.⁶⁹

Using CO₂ captured from heavy industry to access hard to reach gas in depleted oil fields can overall increase the amount of CO₂ in the atmosphere by increasing fossil fuel use. CC(U)S is unproven at scale, increases the fuel usage of the plant, continues highly destructive mining practises—including the release of climate changing methane when coal is mined, increases plant operation costs, requires large infrastructure to link the polluting plants to the disposal sites; could result in sudden large CO₂ leaks, encourages construction of CO₂ intensive industries with the assumption CCS will deal with the CO₂ at a later date; and detracts from actually reducing the amount of CO₂ in the first place.⁷⁰



Reduction in steel use

Reducing steel use can be achieved by improvements to the steel produced and by increasing efficiencies in the consumption of steel.

ArcelorMittal, the world's second biggest steel maker, is investigating a number of different methods of reducing the carbon emissions from steel. One way is by using different construction techniques to create thinner, lighter, high-performance steel.⁷¹

Global steel company decarbonisation

According to World Steel⁷², an industry association, the five biggest steel producers are:

- 1 China Baowu Group
- 2 ArcelorMittal
- 3 HBIS Group
- 4 Shagang Group
- 5 Nippon Steel Corporation

Steel Tonnage 2020 (millions of tonnes)
115.29
78.46
43.76
41.59
41.58

Four of the five biggest steel producers are making big efforts to reduce their production of carbon emissions. A reduction in carbon emissions from these industry leaders means that other producers of steel will follow suit to stay competitive, especially as consumers of steel become more conscious of the options for greener steel. This will widen the uptake in alternative methods to using coking coal in steel production.

China Baowu Steel Group

The largest steel producer globally is the Chinese state-owned Baowu Steel Group has set a 2050 goal to become carbon neutral. Baowu aims to reach peak emissions in 2023.⁷³ The company is increasing its use of scrap steel in an attempt to ease its dependency on coking coal and iron ore.⁷⁴

ArcelorMittal

This Luxembourgish multinational was, until recently, the largest producer of steel. It is one of the biggest corporate carbon emitters in the world. ArcelorMittal owns the mines that extract nearly half of its own iron ore and some of its coking coal.⁷⁵ It produces over 25% of Europe's steel output, while emitting 196 million tonnes of CO₂ annually. The company is aiming to reach net zero carbon emissions by 2050.⁷⁶

At present ArcelorMittal mainly uses blast furnaces but also utilises electric arc furnace steel production and direct

reduction iron technology at some of its European plants.

ArcelorMittal is running a pilot project to use hydrogen as a reducing agent at the company's Hamburg steelworks which has been exploring producing steel via electrolysis for a number of years.⁷⁷ In Hamburg, natural gas is used as a reduction agent instead of coking coal. At the Torero demonstration project in Ghent, Belgium, ArcelorMittal uses biocoal to reduce iron ore.⁷⁸ The company says it uses waste wood, but there is a limited supply of truly waste wood so some of what companies call 'waste wood' actually comes from virgin forest.⁷⁹

ArcelorMittal has received €1 billion of Spanish Government investment for decarbonisation technologies at the Asturias' plant in Gijón, in the north of Spain. This involves a green hydrogen direct reduced iron unit and a hybrid electric arc furnace. If there is insufficient green hydrogen available the facility will run on gas.⁸⁰

HBIS Group

This Chinese state owned steel manufacturer aims to bring its carbon emissions to a peak in 2022 and achieve carbon neutrality by 2050 with shorter term goals along the way.⁸¹ Consequently, it is building a new steelworks - HBIS Serbia - to make primary steel using gas not coking coal.⁸² Its other European steel production facility, Makstil, in Macedonia, recycles scrap steel in electric arc furnaces.⁸³

Shagang Group

The largest private steel enterprise in China, Shagang Group has very little publicly available information regarding its decarbonisation plans written in English. The Group is working with French multinational, Air Liquide, to build a new carbon capture and storage project in Zhangjiagang City, Jiangsu Province, China. If completed it would be the largest single CCS unit of this sort for the steel industry globally, supplying krypton and xenon for Air Liquide to the Electronics industry.⁸⁴ It is unclear how much this one project will lower the overall emissions of the company.

Nippon Steel Corporation

This Japanese company aims to lower CO₂ emissions from its operations by 30% by 2030 from 2013 levels.⁸⁵ Nippon's only European production facility is in Sweden, run by its subsidiary, Ovako, which makes steel from scrap steel. The company already has an 80% lower carbon footprint compared to the global average. Ovako has had the first successful full-scale trial in an existing production environment using hydrogen instead of liquid petroleum gas to heat steel before rolling.⁸⁶

Four of the five global steel makers are showing clear intent to move away from coking coal in steel. This will have a knock-on effect across the industry globally as other companies try to remain competitive and reduce emissions by cutting out coal use by investing in alternative forms of steel production in the next investment cycle.



Section 4 Extraction and consumption

There are various technological attempts to reduce the high levels of CO₂ released in steel production. Technologies available now and those under development are not without their own issues though. As a consequence, we need to use a variety of solutions in combination to reduce the contribution to climate change from the global steel industry.



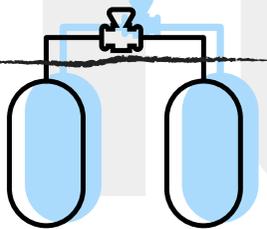
Scrap metal-based electric arc furnace



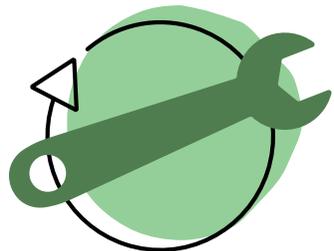
Hydrogen-based solutions



Natural gas-based reduction



Carbon capture (utilisation) and storage



Efficiencies in production and consumption e.g. producing lighter, stronger steel requiring less to be used. Reduction of steel used through increased use of the circular economy.

Positives

Does not require coking coal or additional iron ore.

Low emissions if the hydrogen can be created without fossil fuels/biomass (green hydrogen).

Available now.

Could be retrofitted to existing steelworks.

Reduces emissions but also other issues associated with steel production.

Negatives

10-15% of the equivalent energy required to make new steel is still needed when recycling steel. 100kg of CO_2 is released in producing one tonne of recycled steel directly, and the source of electricity, such as coal, can add another 300kg per tonne of steel.⁸⁷

Hydrogen production is not yet available at the necessary quantity. If hydrogen production increases it may be prioritised for other uses over steel.

Could lock us into substituting one fossil fuel for a slightly less carbon rich one.

Requires large amounts of additional energy to power it and does nothing to address the injustices caused by the extraction of resources or distribution of produced materials. Needs further research and development which could instead be done to prevent carbon production in the first instance.

Could negatively impact jobs in the steel sector but these may be compensated for by increases in other industries using similar skills and in the circular economy.

Technology advance is not without its own issues. As a consequence we need to use a variety of solutions in combination to enable climate change to be brought under control.

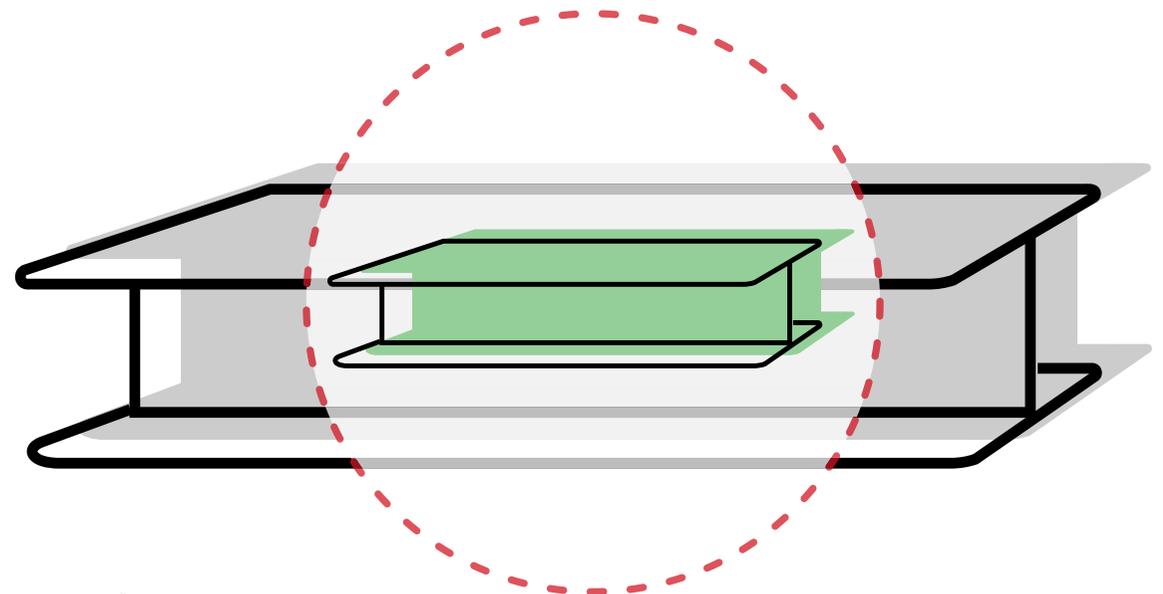
Significant reduction in the amount of steel used

Deeper, more structural solutions to reducing the emissions and supply chain impacts of steel production could include:

- **Reduced use of steel.** In the construction industry, steel and cement are often overused by as much as 50%.⁸⁸ *The Use Less Group* at Cambridge University point out that “one tonne of steel costs around the same as one day of a design engineer’s time”. Instead of over-engineering, construction projects could pay engineers to calculate more accurately the amount of material needed. The Material Economics (2019) *Industrial Transformation 2050* report says, “Construction projects often use 35–45% more steel than is strictly necessary.”⁸⁹ Reducing this does not require big technological changes, but a shift in approach across the industry.
- **Greater use of the circular economy.** This involves sharing resources, constructing things to last and to be repaired (instead of planned obsolescence where items are designed for short lives and to be thrown away); changing the layout of cities, improving public transport, and increased home working options in some sectors so we travel less

by car; using carefully managed regenerative materials such as wood; and more can all impact the amount of materials and possessions we consume and manufacture.

Reform within the steel sector is urgently needed. But given current and projected global increases in steel consumption, the absolute savings in CO2 and other impacts from this reform alone are inadequate. Rethinking our current consumption patterns to move away from one premised on the impossibility of endless growth must be seriously debated within the mainstream narrative.



Why we need to stop mining coal.

Local impacts

At a local level, coal extraction is a highly polluting and destructive practice with the same techniques used for both thermal and metallurgical coal. Coal is removed either by underground or opencast mining. Today's underground coal mines go deep under the earth where very technical machinery is operated, offering few jobs. Opencast extraction destroys everything which lies above the coal, obliterating the ecosystems and the bedrock causing dust, noise, water pollution; wiping out wildlife and polluting waterways.

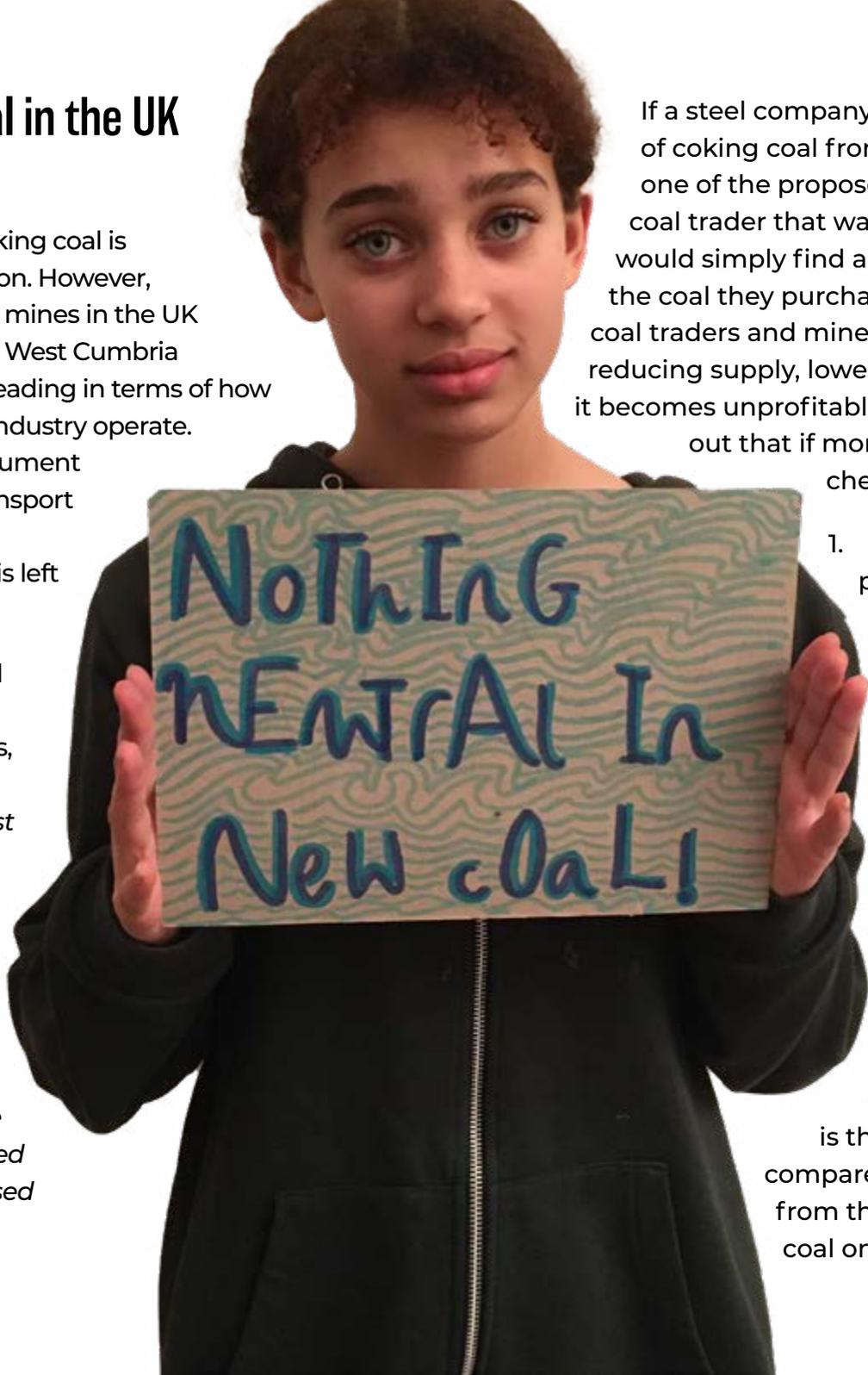
Alexander, an indigenous Shor resident of Chuvashka, Siberia said *"There are opencast coal mines all around our village. They have big explosions in them which sends dust into the air. Wherever the wind comes from it brings more dust. When the wind blows after an explosion you can see the pollution in the atmosphere and on this large a scale it causes cancer. The explosions, the pollution and the chemicals are damaging us. You can see it in the air, it concentrates in our organs, you can't see all the toxins only the dust."*⁹⁰ The mines near Chuvashka produce coking coal—much of which is sold to European steelworks.⁹¹

Coal Action Network actively supports campaigns against coal mines in other parts of the world which supply the UK steel and energy markets. Decarbonisation of steel production in favour of methods which do not require mining coal would protect communities living in the coal mining regions of the world. These communities often see little to no benefit from the industry and bear the greatest localised burden from the pollution and ecological destruction it creates. Solidarity actions and dialogue between people in the UK and those living near sites of coal extraction in countries supplying the coal to Europe can start to challenge the practice of offshoring the damage caused by mining to places away from the gaze and possible concern of the ultimate consumers.

Why mining more coal in the UK will not help

At present most of Europe's coking coal is mined from outside of the region. However, to claim that opening new coal mines in the UK reduces coal mining abroad, as West Cumbria Mining Ltd does, is deeply misleading in terms of how both coal mines and the steel industry operate. West Cumbria Mining Ltd's argument that British mining reduces transport emissions, assumes that the corresponding amount of coal is left underground.

In an objection to the proposed Cumbria coking coal mine, Economics Professor Paul Ekins, University College London, said *"There is no evidence to suggest that coal from the new mine would result in reductions in coal extracted from mines overseas. Basic economic theory suggests that [...] an increase in the supply of a commodity such as coking coal will reduce the price of the commodity, leading to increased demand, and therefore increased emissions."*⁹²



If a steel company in Europe were to switch its supply of coking coal from a mine in a different continent to one of the proposed mines in the UK, the international coal trader that was supplying the UK steel company would simply find another buyer and would not reduce the coal they purchase by an equivalent amount. The coal traders and mines will seek alternative markets before reducing supply, lowering the price to create demand until it becomes unprofitable to operate. Paul Ekins OBE points out that if more coking coal was available, and at a cheaper price, it would:

1. result in increased steel production using more coking coal, ultimately resulting in greater local and global harm to humans, animals, and climate change.
2. reduce the profit-motive for the steel industry to invest in developing alternatives to relying on coking coal or improving recycling rates of scrap steel.⁹³

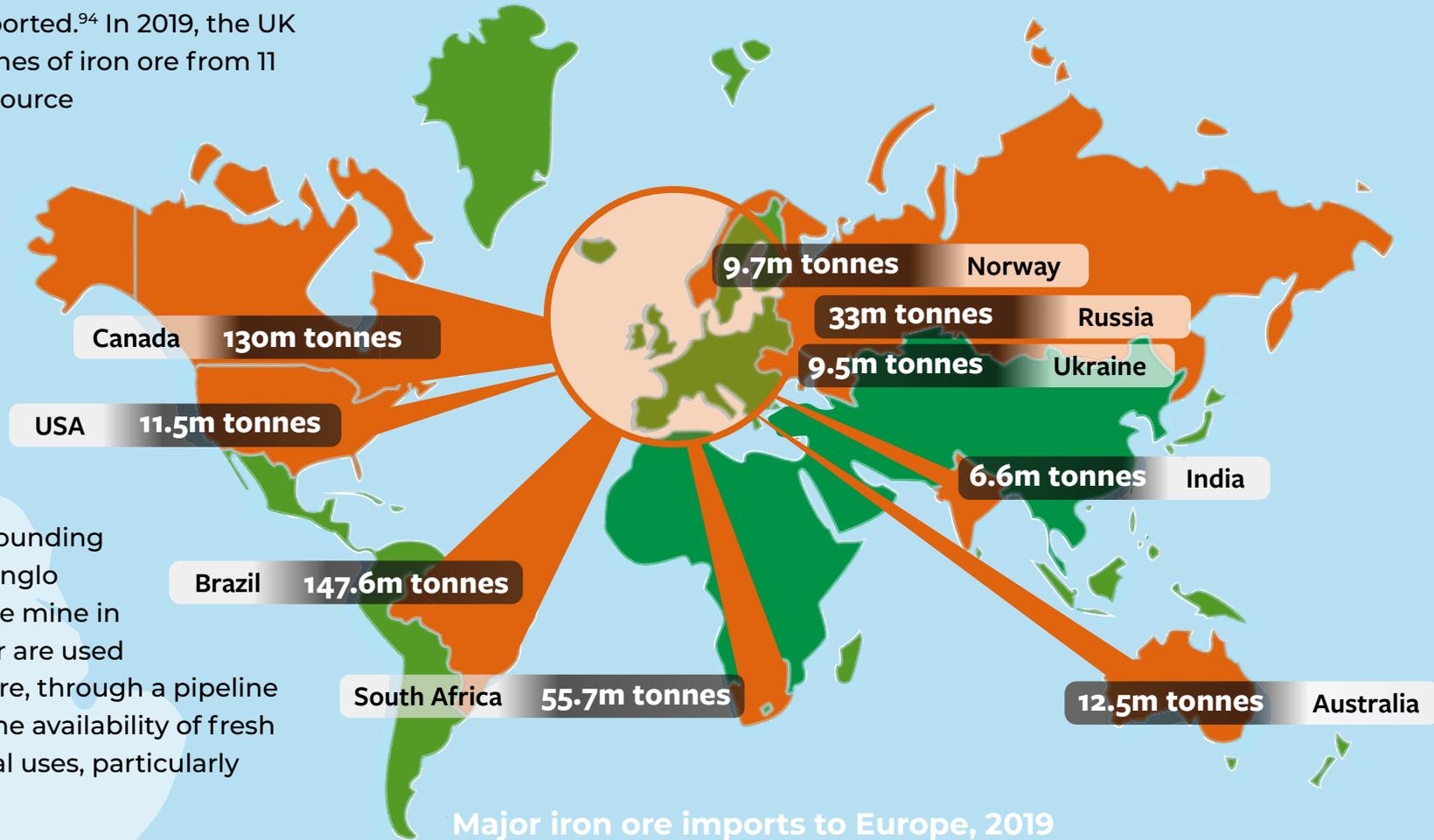
The UK mining industry tries to focus attention on emissions associated with transporting coal long distances to justify new coking coal mines in the UK, but the reality is that these emissions are insignificant compared to the increased carbon released from the consequences of putting more coal on the market.

Iron ore extraction and human rights

It is important to consider the mining impacts of iron ore when producing virgin steel as there are environmental and human rights abuses here, as well as with coal extraction.

All of the UK's iron ore is imported.⁹⁴ In 2019, the UK imported over 17 million tonnes of iron ore from 11 countries. Year on year, the source countries change. For example, in 2018, the UK imported large quantities from Egypt and Liberia in addition to the countries supplying Europe shown in the image.⁹⁵

Mining for iron ore causes substantial issues for the people and ecosystems surrounding the mines. For example, at Anglo American's Minas Rio iron ore mine in Brazil, high volumes of water are used to transport the powdered ore, through a pipeline to a port. This has reduced the availability of fresh water for other essential local uses, particularly agriculture.⁹⁶



Another issue with iron ore mines is the credible and perpetual threat of collapsing dams containing potentially huge volumes of contaminated waste. In 2015, the Fundão mining waste (also known as tailings) dam at the Samarco iron ore mine in Minas Gerais, Brazil, collapsed. The mine is owned by two mining giants, 50% belongs to BHP (formerly BHP Billiton) and the rest is owned by Vale.

“The dam break led to the destruction of all forms of life in the region. Mud covered everything, resulting in 20 deaths and unmeasurable environmental destruction. We have seen whole communities destroyed by BHP Billiton and Vale’s operations. They have lost everything, without receiving any real compensation. Instead of reparations for the victims, what is becoming evident is the blatant corporate capture of

our government by transnational companies”, said Rodrigo de Castro Amédée Péret, of the Churches and Mining Network in Latin America.⁹⁷

Because of the dam collapse, 700 people were made homeless and hundreds of kilometres of the Rio Doce River valley was polluted.

Like with many other mining operations, large areas of land are laid to waste by the extraction of iron ore, and local people and ecosystems are exploited. In May 2020, mining giant Rio Tinto destroyed a 46,000 year old Aboriginal heritage site in the Juukan Gorge, in western Pilbara, Western Australia. Rio Tinto was expanding the multibillion-dollar Brockman 4, iron ore mine. The company had no consent from the traditional owners of the land to operate there.⁹⁸



Section 5 How we will get change

Rapid policy development and industrial strategising is needed to create the necessary changes to reach net zero within the UK's steel sector by 2035, as there is only one steelworks investment cycle before then. An investment cycle is the amount of time for money to be invested in new technology and for that to be built and become operational.⁹⁹

Caitlin Swalec of Global Energy Monitor, a San Francisco energy policy think tank, says, *“the investment cycle for steel production sites, [...] is approximately 15–20 years for BF-BOF plants and 20–25 for DRI, over an average 40 year plant lifetime. This timescale means that over the next decade, steel plant owners will need to make difficult decisions about whether coal-based furnaces should be prolonged, retrofitted, or replaced with lower-emissions technology.”*¹⁰⁰

There are already moves by steel consumers to demand lower carbon products—for example from Volvo: *“We are determined*

to be a climate-neutral company by 2050 in line with the Paris Agreement. This means that[...] we will review the materials, like steel, used in our products and will gradually switch to fossil-free alternatives here as well. This is an important step on the road to completely climate-neutral transports” says Martin Lundstedt, President and CEO at Volvo Group.¹⁰¹ The first green hydrogen produced steel made by the HYBRIT project was delivered to Volvo who intend to start production in 2021 of prototype vehicles and components with the green steel.¹⁰²

There is currently excess global steel production. Global Energy Monitor's survey of large global steelworks,¹⁰³ the '[Global Steel Plant Tracker](#)' shows that current steelmaking capacity is about 25% higher than steelmaking production. This means that many older and polluting steelworks can be closed without disrupting global supply. As the UK produces 65% of the quantity of steel it consumes, that does not have to mean closing any British steelworks, but it could mean the closure of European steelworks with the highest emission rates. The combined overcapacity of the European Union and the UK as a percentage of total production in 2020 was 26.6%. So the worst carbon emitting steelworks can be closed whilst continuing to meet demand.¹⁰⁴

There is a risk that steelworks which refurbish without decarbonising will create stranded assets—with facilities which are built with the associated costs, but which cannot be used to the planned capacity or duration, due to decarbonisation timetables from government.¹⁰⁵

Collaboration is needed from government to invest in lower carbon steelmaking techniques and to control prices to make the technologies financially viable and widely used. Researchers from Cambridge University explain how this could be achieved in the *Steel Arising* report, “*The UK government could support businesses in exploiting these advantages by combining steel energy and climate policy, by setting emissions reduction targets based on consumption rather than production, and by pulling the levers of technology, waste, trade and procurement policy to create the most favourable conditions for business innovation in adding most value to the least steel made by recycling*”.¹⁰⁶

Ways everyone can bring about change

Decarbonising the steel sector is not something that many of us feel in a position to directly influence. However, you can join the campaigns against new coal mines, making it harder for the steel industry to continue relying on new supplies of coking coal for a business-as-usual approach to steelmaking.

South Lakes Action on Climate Change (SLACC) are fighting West Cumbria Mining Ltd’s application to extract coking coal. You could get involved in [SLACC’s campaign](#) directly, through Coal Action Network, or through other groups fighting this proposal such as Friends of the Earth.

Other things you can do:

- Order a copy of [Still Burning: Coal, colonialism and resistance](#) written by the European Still Burning Network, which details the mining and climate impacts of coal imported to European steelworks and coal power stations, with suggested ways to fight back.

- If you buy products with steel in, ask the companies where that steel comes from, and whether they will look into sourcing it from greener producers. Volvo and others show that consumers care about the embodied emissions in final products.
- Fight against injustice in your own community. Addressing climate change and social injustice wherever it applies in your situation aids the overall picture.
- Sign up to receive emails from Coal Action Network about our campaigns against coal mining or follow us on social media ([@CoalActionUK](#))

Collective action suggestions:

- Push governments to invest in a Just Transition for workers while converting to lower carbon steelmaking techniques that require different skill sets, which would provide work for displaced employees into green steel and the circular economy to protect jobs.
- Demand the government implement truly green public procurement policies to ensure long term demand for green steel, as the public sector is a very large consumer of construction materials, encouraging investment.¹⁰⁷
- Pressure your elected representatives to push for steel decarbonisation and government backed, emissions-based green steel certifications to counter polluting industry techniques and false solutions like ‘Responsible Steel’, where the steel industry self-certifies and advocates for continued use of metallurgical coal.
- Talk to people in your community about steel, its impact on the climate, as well as its supply-chain impacts on local ecosystems and people around the sites of mining it demands.

Conclusion

Coking coal is currently used in most of the steel production in the UK and Europe. This results in high environmental costs, particularly through carbon emissions. In the UK, the second and third biggest single site emitters of carbon and the two biggest steelworks—Port Talbot and Scunthorpe Steelworks. Coal usage in steel is preventing the sector from decarbonising—which is essential if the UK is to meet its net-neutral by 2050 target.

There are alternatives to using coal in steel. Some of these already exist such as electric arc furnaces recycling scrap steel and direct reduction iron production with gas. Others technologies are expected to be producing greener steel at commercial-scale by 2026, with pilot demonstrations already proving successful. With potential improvements in efficiencies and approaches to consumption that could result in less steel being used, a significant decarbonisation of the sector is possible if there is bold and collaborative action from steel companies, government, steel workers, and steel consumers at all levels.

The future for the steel industry depends on various factors and a combination of methods to decarbonise the sector are likely to be deployed. For example, through greater use of the circular economy and reduced over-engineering in steel applications, the quantity of steel used can be reduced. Where steel continues to be used, it can come from either recycling of scrap steel or production of primary steel produced using green hydrogen with greater transparency and scrutiny over the

methods by which the raw materials are sourced.

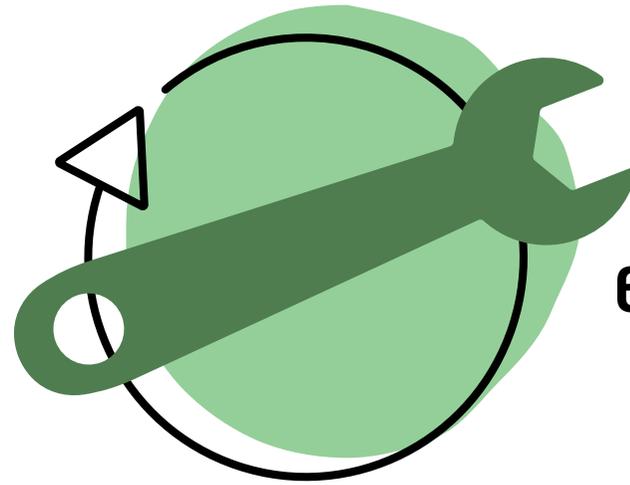
This report hopes to catalyse conversations and further research. It is important that we consider it may be necessary to make radical changes to the way in which we live, work, and travel to reduce our need for steel and consumable goods.

The International Energy Agency expects steel production to increase by 30% by 2050, but many are questioning whether the damage that comes with the increased mining this would demand can be justified. Covid-19 has shown that rapid and significant changes are possible if the will is there at all levels of society. We may need to foster the will in ourselves and others to find ways and courage to step outside of the current growth-based consumption model, and use our skills to ensure we meet our needs without denying others and our future generations the same.

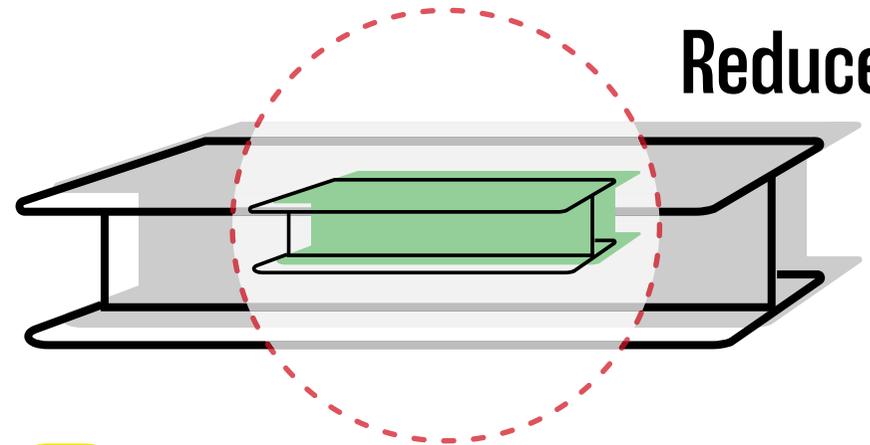


Whatever the path to a low-carbon future looks, it will not include the continued use of coal-based steelmaking technologies and techniques which have barely changed since the 1700s¹⁰⁸. The UK government has a choice as to whether to invest and encourage a transition to a low-carbon, coal-free steel industry, or allow the UK and its construction businesses to languish in using old techniques. Our future climate relies on the right choices being made.

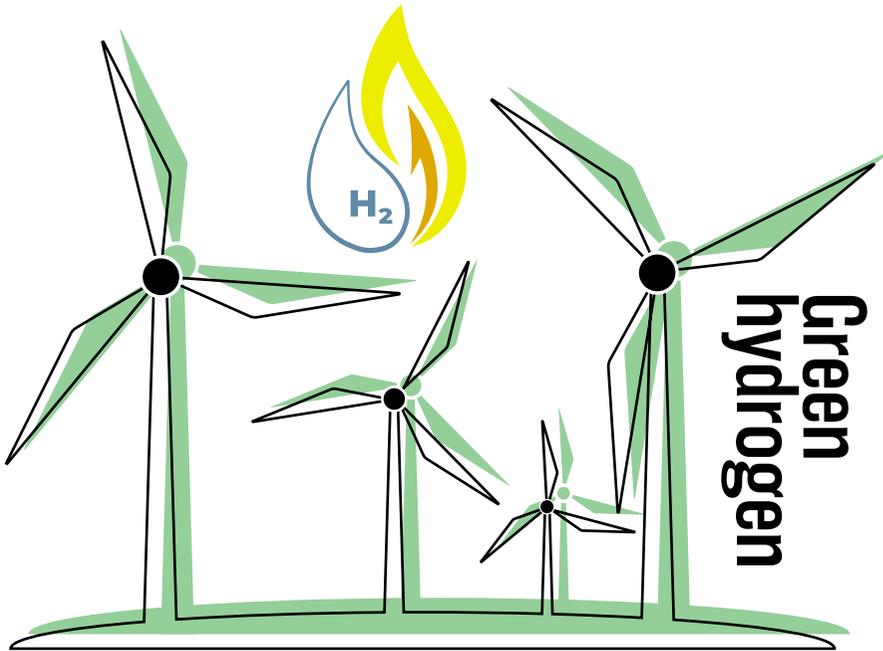
We need to use the whole toolbox to fix coal in steel



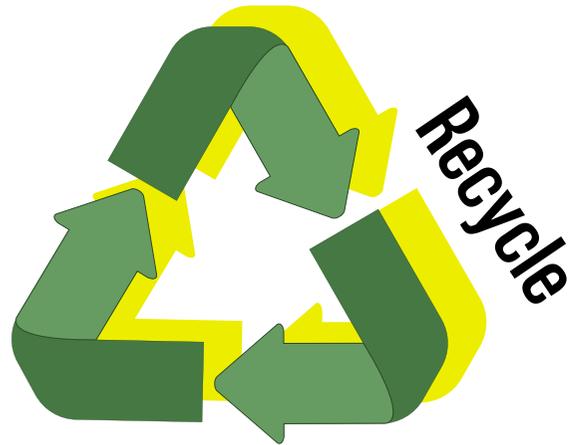
Re-engineer with a circular economy



Reduce



Green hydrogen



Recycle



Supply chain scrutiny

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