Briefing

Clearing the air: a cleaner, healthier future for the UK's steel industry, communities and workers

October 2024

Summary

The steel industry is important to the UK economy, providing jobs, supporting supply chains and having deep local and cultural connections.

However, the industry has also been responsible for 15 per cent of the UK's industrial carbon emissions and has been the largest source of industrial particulate matter pollution in the UK and EU. The future of the UK's steel industry can be cleaner. People should not have to choose between local jobs and breathing healthy air.

Air pollution from steelmaking has serious health implications for the industry's workers, as well as local communities. Major pollutants from steelmaking include carbon monoxide, particulate matter, nitrogen oxides and sulphur dioxide. These are associated with health risks, including respiratory illness, asthma, cancer and preterm births.

As the industry transitions to new, greener technology, such as electric arc furnaces, emissions of these major pollutants should decrease significantly. Our analysis of current industrial emissions found that the UK's electric arc furnaces produce five times less nitrogen oxides, 16 times less sulphur dioxide, 37 times less carbon monoxide, four times less PM10 particulates and less than half the amount of PM2.5 particulates per tonne of steel than old technology blast furnace production in the UK.

However, electric arc furnaces are not completely pollution-free. Currently, in the UK, they emit more heavy metal pollution per tonne of steel than blast furnaces, particularly chromium and zinc, which can be toxic after prolonged exposure.

The government should update UK's air pollution policy to ensure that the future of the steel industry is clean and protects workers and communities.

Action needed:

1. **Continued dialogue with communities and workers on the future of steel plants, to ensure jobs are supported, and lessons are learnt for other industries.**

2. **Update UK ambient air quality targets, in line with World Health Organization guidelines.**

3. **Ensure the new UK process for agreeing emissions limits from industrial activities reflects genuine international best practice on emission limits.**

UK steel production and the political context

The steel industry is vital to local economies and supply chains across the UK. The steel market has the potential to grow by up to 26 per cent by 2030 to meet the needs of the net zero transition, eg for building wind turbines.[1] But steel manufacturing is changing, with new technologies being adopted that reduce carbon emissions.

Before September 2024, steel manufacturing was responsible for 15 per cent of the UK's industrial carbon emissions.[2] Over 90 per cent of the direct carbon emissions from the UK steel industry came from two sites, in Port Talbot and Scunthorpe, using blast furnace and basic oxygen furnace (BF-BOF) steelmaking, where coal was used to reduce iron ore to iron before being turned into steel.[3]

On 30 September 2024, the second of the two blast furnaces at the Port Talbot site closed, under a plan to shift to electric steel production, using scrap steel in electric arc furnaces (EAFs).[4] The steel plant in Scunthorpe also plans to shift to EAF production, but no dates are confirmed yet. Some primary iron will still be needed for a small number of products, either via imports or produced domestically through hydrogen direct reduction.[5]

The government has committed to subsidise investment in an EAF at Port Talbot.[6] While this will safeguard some jobs in the industry over the long term, there will still be considerable job losses due to the technology change. The plan has faced a backlash from local communities where steel production is an important part of the local economy, history and identity.

Investment in UK steel production is not only important for jobs and local heritage. It is also an opportunity to ensure that the future of steel production in the UK offers workers and local communities a safer, healthier future. Steel production does not only produce carbon emissions, but also a range of other air pollutants which have an impact on the health of workers and local communities.

As steel production decarbonises, and new methods of production expand or are introduced to the UK, standards and policy should be developed to protect workers and communities.

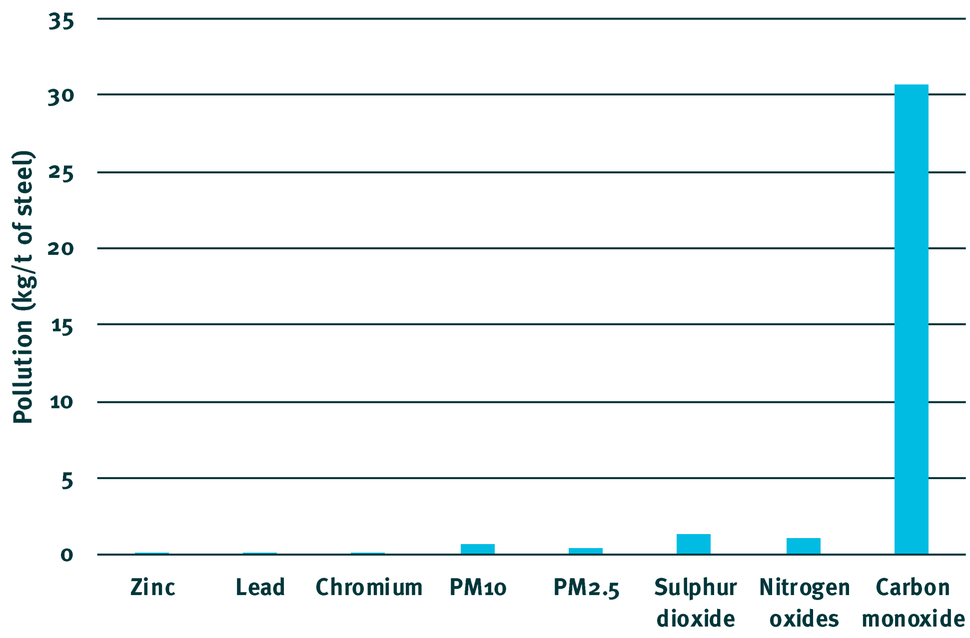
Emissions from steel production

Steelmaking involves multiple processes, each emitting different types of air pollution. Raw material inputs, products made, the age of plants, management of processes and the technologies used all vary depending on the site and influence how much pollution is emitted.

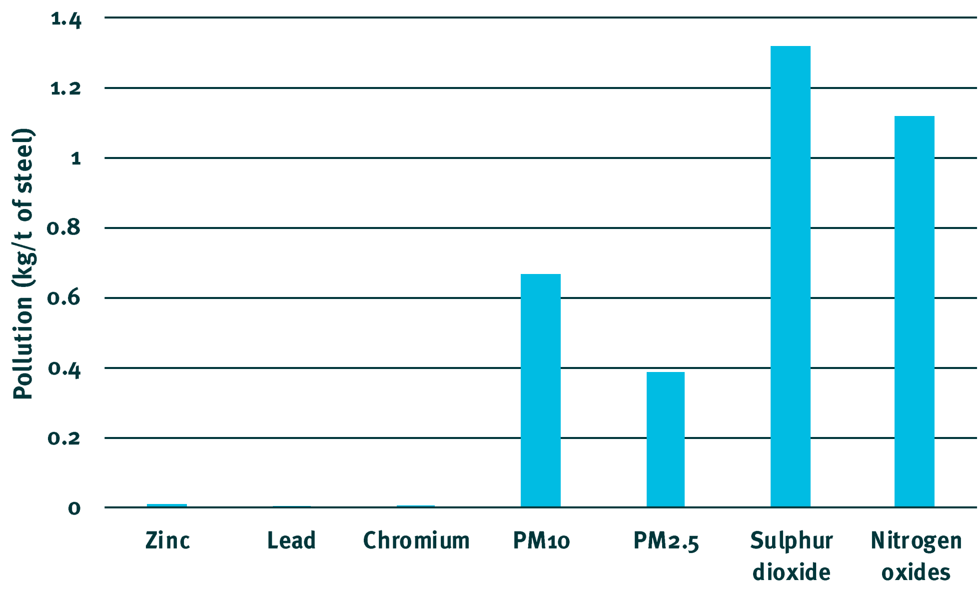
For traditional blast furnace production, the first step is preparing raw materials through coking and sintering. During these processes, particulate matter, as well as carbon dioxide, is produced. The second step is the blast furnace where molten iron is created. This emits sulphur oxides and particulate matter. At the third step, called the basic oxygen furnace (BOF), steel is made from molten iron and additives. Pollutants emitted during this stage include particulate matter, sulphur dioxide, nitrogen oxides, metals, such as lead and manganese, and other volatile compounds.[7] The steelmaking process is followed by further downstream processes such as rolling, to make steel sheets and bars in the form needed for manufacturing and infrastructure.

Iron and steel is the largest industrial source of particulate matter air pollution in the UK and EU.[8] In 2021, the major pollutants averaged across UK blast furnace production were carbon monoxide, nitrogen and sulphur oxides and particulate matter, with smaller amounts of heavy metals.[9] This analysis is based on data for sites across the UK that include coking, sintering, blast furnace, basic oxygen furnace and rolling. Further downstream processes are not included in this analysis as they tend to be carried out on separate sites and are independent of the technology used for steelmaking.
Both the Port Talbot and Scunthorpe blast furnace production sites recently closed their coking ovens, which should reduce emission from these sites, but there is no data available yet.[10,11]

Carbon monoxide is the major pollutant from blast furnace production...



... but nitrogen oxides, sulphur dioxide and particulate matter are also important

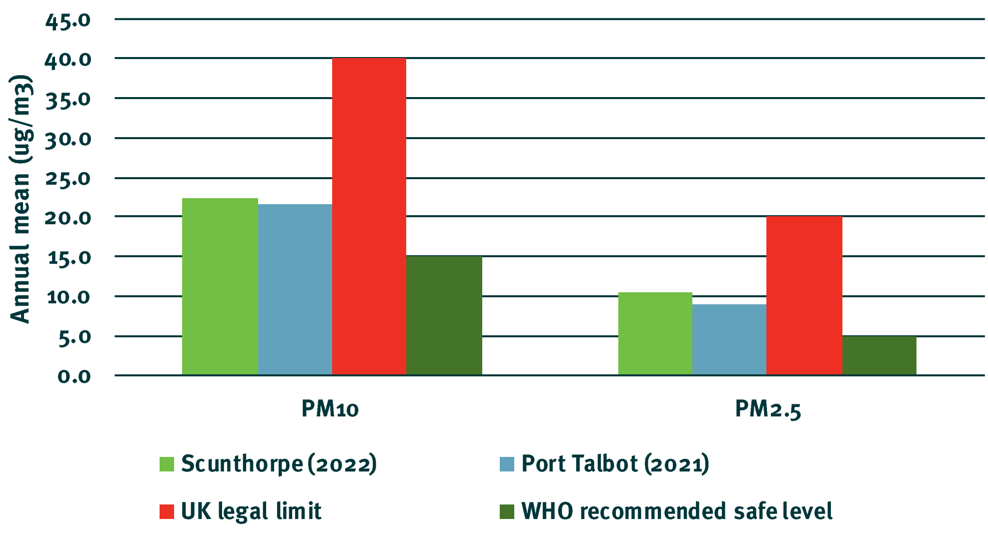


How pollutants disperse

Air pollutants disperse beyond the industrial sites themselves and into the local area, where they mix with other pollution from sources such as road traffic. For example, in Port Talbot, the council has stated that emissions of particulates and polycyclic aromatic hydrocarbons (PAHs) are mainly related to the steelworks. This is compounded by pollution from the M4 motorway which affects the area.[12] According to the latest report from the council, in 2021 there were numerous instances where the daily concentration of particulate matter in Port Talbot broke UK legal limits and, for some pollutants, it was over twice the safe levels recommended by the World Health Organization (WHO).[13] The area between the steelworks and the M4 motorway continues to be under special management for air quality by the local authority.[14]

Weather conditions and the prevailing wind direction can lead to higher concentrations of pollutants in certain areas. For example, in Scunthorpe, areas immediately around and to the north east of the steelworks suffer from particularly high concentrations of pollutants, including particulate matter with a diameter of 10 microns or less (PM10) and PAHs (Benzo(a)pyrene). North Lincolnshire Council has stated this is directly related to the location of the steelworks and prevailing winds.[15] Hot weather can also make air pollution worse due to faster evaporation from roads and stockpiles. According to the latest report from North Lincolnshire Council, heatwaves in 2022 may have contributed to an increase in breaches of the UK legal air quality limits for PM10 in the area in that year.[16]

Particulate matter pollution surpasses the WHO recommended safe levels[17]



The impact of pollutants on health

Air pollution is associated with numerous health risks, including chronic bronchitis, chronic mortality, preterm births and asthma attacks.[18]

Pollutant	Associated health risks[19]
PM10 PM2.5	Fine particles are carried deep into the lungs, causing inflammation and worsening pre-existing heart and lung diseases. Particulate matter has been classified as carcinogenic.
Carbon monoxide	Exposure to this gas prevents the uptake of oxygen in the blood, leading to a reduction in supply to the heart. Exposure can also result in symptoms that resemble flu and viral infections.
Nitrogen oxides Sulphur dioxide	These gases irritate airways, reducing lung function and exacerbating the symptoms of those with pre-existing respiratory conditions.
Heavy metals	Large amounts of heavy metal pollution can be toxic, affecting the function of major organs.
Polycyclic aromatic hydrocarbons (PAHs) eg Benzo(a)pyrene	Inhaling PAHs over years can lead to increased cases of lung damage, breathing problems, skin irritation, weakened immune systems and heart disease.[20]

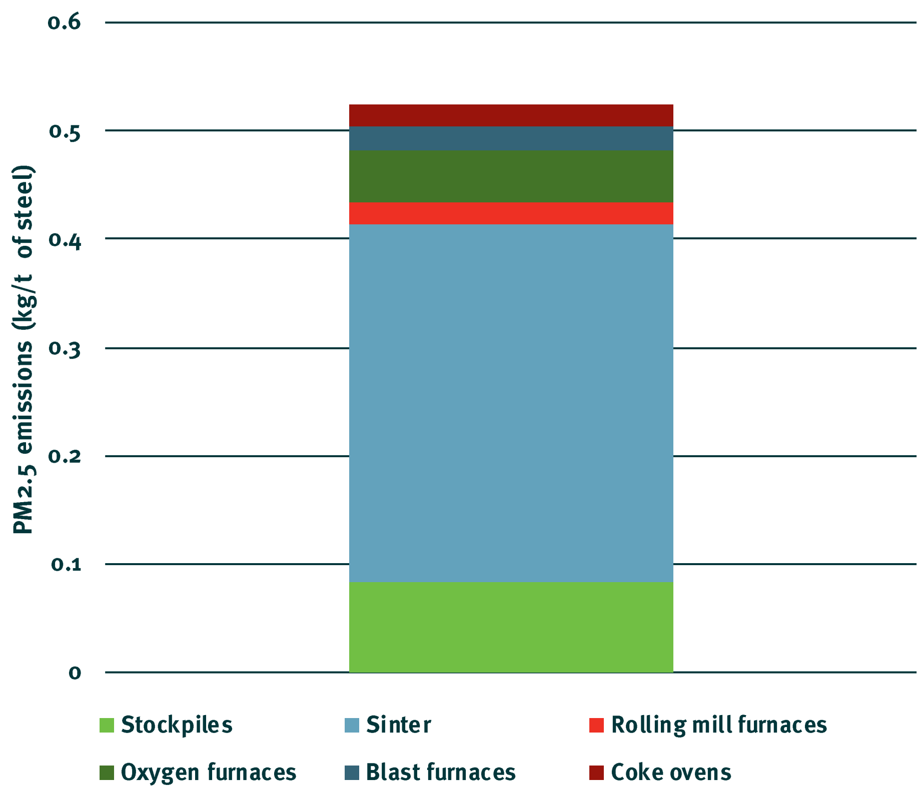
These risks worsen the longer people are exposed to pollutants and present a greater threat to children, older people and those with pre-existing health conditions. The Centre for Research on Energy and Clean Air (CREA) estimates that life expectancy is reduced by ten to 20 years on average for air pollution related deaths. The centre's health impact modelling for Europe suggests there are 182 air pollution related deaths per year in the UK as a result of pollution from the iron and steel industry.[21] This Europe-wide modelling does not consider local factors or where people live in relation to the sites.

A Netherlands government assessment of the health impact of emissions from a steel plant in Ijmulden on town residents showed that their life expectancy was reduced by 2.5 months on average. Specific increases in lung cancer and childhood asthma risks were also found, with four per cent of new lung cancer cases and three per cent of new asthma cases in children attributable to the plant's emissions.[22] There is no comparable study for Port Talbot or Scunthorpe, and local variations in health and other socio-economic factors will have an impact.

Differences between blast furnaces and electric arc furnaces

For blast furnace production, there are three stages: coking and sintering, blast furnace and basic oxygen furnace. The largest share of particulate matter emissions come from the sintering stage, where iron ore powder is processed for the blast furnace.

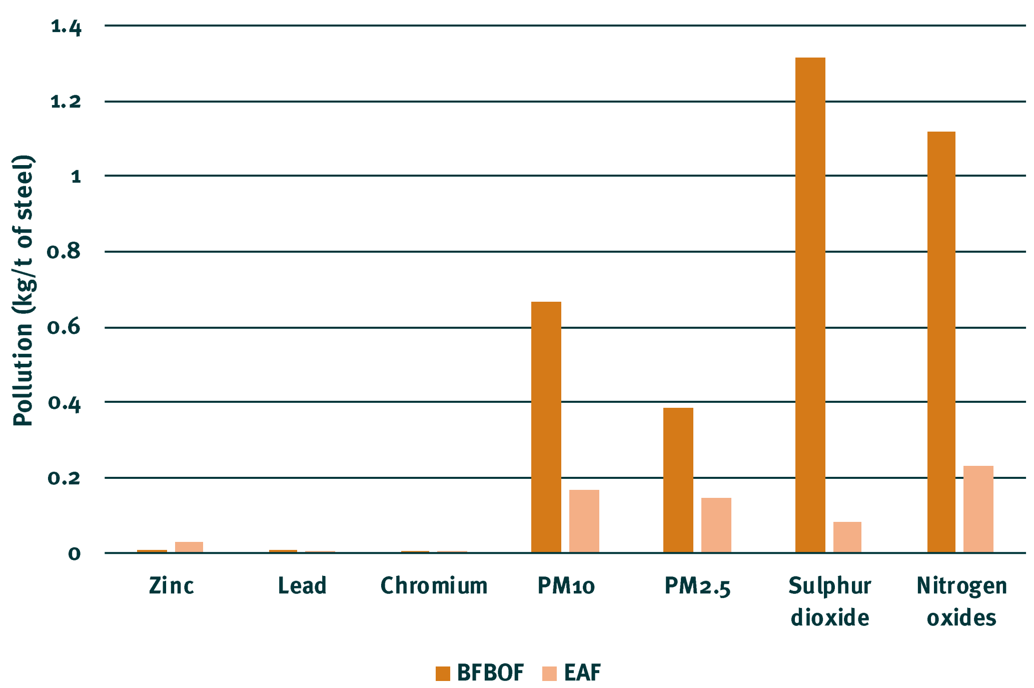
The sintering stage produces the majority of particulate matter emissions



Electric arc furnaces (EAFs) melt down scrap steel, so there are no emissions associated with fuels or sintering.[23] Our analysis of current industrial emissions found that EAFs produce five times less nitrogen oxides, 16 times less sulphur dioxide, 37 times less carbon monoxide, four times less PM10 and less than half the amount of PM2.5 per tonne of steel than BF-BOF production.[24]

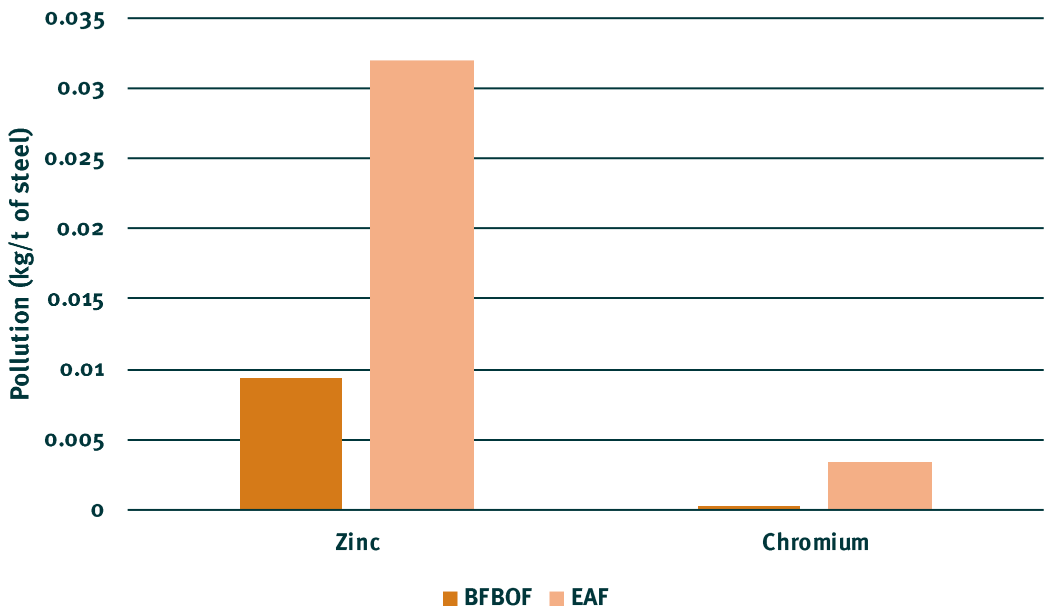
Producing primary steel through hydrogen direct reduction with an EAF is an emerging technology with only trial plants operating so far. However, it is likely to have lower emissions than blast furnace production, as it does not involve the use of coking coal or sintering. It does require converting iron ore into pellets using a furnace, but the emissions from this process are lower than from sintering, with one study suggesting the sulphur dioxide, nitrogen oxide and dust emissions of pelletising are less than five per cent of those from the sintering process.[25] Hydrogen direct reduction with an EAF may, therefore, have lower emissions than blast furnace production, but higher than scrap EAF production.[26]

For most pollutants, EAFs have lower emissions than blast furnaces (BFBOF)



Current scrap steel EAFs, though much less polluting than blast furnaces, are not perfectly clean. Data on emissions averaged across current EAFs operating in the UK shows they emit more heavy metal pollution per tonne of steel made, particularly chromium and zinc, which can be toxic after prolonged exposure.[27] This is likely to be due to a combination of factors, including the sources of steel scrap used in production, such as galvanised steel which contains zinc, the grade and type of steel being produced, as well as the fume extraction technology used on site.

EAFs produce more of some heavy metal pollutants



It is important to note that the data on air pollution from EAFs are based on current sites and existing technology. If new EAFs were built they would need to comply with current air quality regulations and would be likely to adopt more modern technology for extracting pollutants, which can include total EAF enclosures, dioxin abatement and well managed raw material storage areas with concrete bases.

There are also problems with data availability. In compiling the graphs above, we found significant gaps in observed data for key pollutants from the steelmaking process. For example, scientific literature suggests there should be emissions of nitrogen oxides from the sinter, blast furnace, basic oxygen furnace and hot rolling stages of blast furnace steel production, but the data from the National Atmospheric Emissions Inventory (NAEI) pollution inventory shows only emissions from the basic oxygen furnace stage, plus some gas flaring.[28] The NAEI point sources dataset includes modelled data to fill the gaps, which we have used as the basis of our analysis, but it remains unclear why there is a lack of observed data on key industrial emissions. [29]

Pollution control policies

There are two types of regulation which can directly or indirectly manage air pollution from all types of steel production. The first is ambient air quality standards, setting limits for safe levels of air pollutants. These standards capture the impact of emissions from all sources, for example road traffic, wildfires, household log burners and other industrial activities. The UK has ambient air quality standards, adopted into UK law from the EU Air Quality Directive.[30] The Environment Act 2021 introduced a new legally binding targets on PM2.5 pollution.[31] However, the targets are less ambitious than the safe levels recommended by WHO.[32]

Pollutant	Averaging time	UK target[33]	WHO target[34]
PM2.5 ug/m3	Annual	10 (by 2040)	5
	24-hour	None	15
PM10 ug/m3	Annual	40	15
	24-hour	50	45
NO_2 ug/m3	Annual	40	10
	24-hour	200	25
SO_2 ug/m3	24-hour	125	40
CO mg/m3	24-hour	10 (8-hour mean)	4

The second type of regulation controls levels of permitted pollution from different industrial processes. The UK transposed the EU Industrial Emissions Directive (IED) in 2013 and the EU Withdrawal Act 2018 ensured that this continued to be UK law post-Brexit. Emissions standards for each plant are set based on 'Best Available Technologies (BAT)' reference documents for the relevant sector. These show what can technically be achieved by similar plants and are agreed through a process of engagement with industry, experts and environmental groups.

Time for better UK regulation

The current emissions standards agreed by the EU BAT process lag behind standards adopted by China, South Korea, Taiwan and Japan.

China's Ultra Low Emissions (ULE) standards, for example, adopted in 2019, set limits for particulate matter, sulphur and nitrous oxides from blast furnace production which are up to 75 per cent, 94 per cent and 77 per cent lower respectively than current EU and UK standards.[35] Without any change in the production process from blast furnace to EAFs, estimates from the Centre for Research on Energy and Clean Air (CREA) show that, if the UK and EU matched China's emissions standards, it would reduce deaths from air pollution from iron and steel production across the EU - UK region by 65 per cent.[36]

For EAFs, the emissions limit for particulate matter in China is 50 per cent lower than the upper range of the EU limit. However, both sets of standards only consider particulate matter emissions and do not set air emission limits for EAFs for the other pollutants we have analysed, including sulphur dioxide, nitrogen oxides and heavy metals like chromium and zinc.[37]

In addition, implementation of standards is too lenient across Europe due to loopholes that allow exclusions, adoption of the most lenient emissions limits in the BAT range, long timelines allowed for making improvements and lack of enforcement.[38]

The EU is currently tightening the Industrial Emissions Directive to ensure stricter enforcement of existing emissions limits and improve public access to data.[39,40] However, this reform does not include an update to the emissions limits set in the BAT process which will be updated in a cyclical fashion. The latest BAT reference document, published by the EU for iron and steel production, was agreed in 2012 and is likely to be updated in the next few years.

Post-Brexit, the UK has its own process for agreeing what would count as best available technology in each sector.[41] The new approach has fewer contributors and, if it is mainly based on the smaller evidence base of existing UK plants, will not be ambitious, but the government has said it is happy to use inputs from plants in other regimes. This presents an opportunity to ensure genuine best international standards and practices are adopted. In some sectors that may require the government to face down industry lobbying. The historical process for agreeing BAT standards often does not reflect genuine best practice due to industry influence.

UK policy recommendations

Improve monitoring and enforcement of air quality targets

The UK has a poor track record on meeting its ambient air quality targets. The government has been taken to court multiple times for breaching them, particularly for nitrogen dioxide.[42] The new oversight body, the Office for Environmental Protection (OEP), now monitors the effectiveness of environmental laws in England and Northern Ireland and scrutinises public authorities' adherence with environmental laws, enforcing non-compliance where necessary. Environmental Standards Scotland performs a similar role in Scotland and in Wales, an Interim Environmental Protection Assessor oversees environmental law, but the role lacks statutory powers.[43] A permanent oversight body has been promised by the Welsh Government.[44]

Air quality targets are within the OEP's remit and, in January 2024, it recommended that the government should consider reviewing all ambient air quality standards in the Air Quality Standards Regulations to bring them in line with WHO guidelines.[45]

Align air quality targets with WHO 2021 guidelines by 2030

Compliance with existing targets is not enough to protect people's health. WHO guideline limits are up to four times lower than UK targets. Breaching WHO guidelines is associated with serious public health risks. The EU is proposing to align with WHO guidelines in its update to the Air Quality Directive.[46] This will save money as well as protecting health. The NHS has predicted the health and social care costs of air pollution could be as high as £5.3 billion by 2035, if current air pollution levels persist.[47]

Align with international best practice

As the UK develops its own BAT process and reference documents, it can resolve some of the issues with the EU system. For example, by looking beyond the EU when assessing best practice, by reducing the number of exclusions, by ensuring the higher end of the emissions limit range in reference documents are adopted by industry, and by reducing timelines for compliance. The UK should mirror EU reforms to the Industrial Emissions Directive to ensure stricter enforcement of existing standards and improve the public's access to data.

When the new UK BAT standard for iron and steel production is developed, it should reflect international high standards, such as those adopted in China, Japan, South Korea and Taiwan and should include air pollutants beyond particulate matter for EAFs.

Ensure full reporting of pollutants

Once there are higher standards, monitoring and enforcement will be crucial to ensure benefits are delivered. Government guidance suggests industrial sites are required to report on the full range of relevant air pollutants, not just what is listed on their permit, to feed into the National Atmospheric Emissions Inventory.[48] However, our analysis of available data shows significant gaps, often filled by modelling rather than observed data, meaning there is significant missing information about the UK's steel emissions. Full reporting would empower the government and civil society to take action to reduce the health impacts on local communities and workers.

Continue dialogue with communities and workers

The steel industry is central to the UK's identity and economy. In Port Talbot and Scunthorpe, the industry has strong public support and cultural value. But for the industry to survive, it will need to decarbonise.[49] Current policy supports the switch to clean steel but fails to manage the social implications of the transition. As a priority, engagement and clear dialogue is needed with trade unions to ensure workers and local communities are not left on a cliff edge. Lessons from this process should be learnt for other industries upgrading their technology and infrastructure. An important part of this dialogue should be to ensure that future steel production in the UK meets or exceeds international best practice air pollution standards, to protect workers and surrounding communities.

For more information, contact:
Heather Plumpton, senior policy analyst
hplumpton@green-alliance.org.uk

Authors: Heather Plumpton, Jasmine Dhaliwal and Roz Bulleid

Endnotes

[1] Green Alliance, 2023, *A brighter future for UK steel*
[2] Green Alliance, 2022, *Building the future: a faster route to clean steel*
[3] Green Alliance, 2022, op cit
[4] BBC news, 29 September 2024, 'Traditional steelmaking in Port Talbot ends'
[5] Green Alliance, 2022, op cit
[6] UK Government Department for Business and Trade, 15 September 2023, 'Welsh steel's future secured as UK Government and Tata Steel announce Port Talbot green transition proposal'
[7] CREA, 2022, *Unveiling the truth behind blast furnace pollution: air quality and health impact assessment of South Korean steel plants*
[8] CREA, 2023, *Upgrading Europe's air: How a strong Industrial Emissions Directive can save lives and money*
[9] Green Alliance analysis of National Atmospheric Emissions Inventory point sources dataset, 2021. This includes both observed and modelled data, to fill gaps in monitoring data and provide as full a picture as possible of emissions from all sites.
[10] British Steel, 5 April 2023, 'British Steel will offer alternative roles to 250 colleagues affected by closure of its Scunthorpe coke ovens'
[11] Tata Steel, 18 March 2024, 'Tata Steel to close coke ovens'
[12] Welsh Government, *Air pollution data in Port Talbot: a collaborative approach to developing good evidence to use in decision making*

[13] Neath Port Talbot Council, 2022, *Neath Port Talbot County borough Council 2022 air quality progress report* and World Health Organisation (WHO), 2021, *WHO global air quality guidelines*. Regarding the daily limit, one monitoring site recorded 33 24-hour means in excess of 50 µg/m3 in 2021, while another recorded 7 exceedances and another recorded 3 exceedances.
[14] Neath Port Talbot Council, 2022, *op cit*
[15] North Lincolnshire Council, 2023, *2023 air quality annual status report*
[16] North Lincolnshire Council, 2023, *op cit*
[17] Data in the graph is based on the latest data available from Neath Port Talbot Council and North Lincolnshire Council air quality reports. UK air quality limits and WHO guidance are from Department for Food, Environment and Rural Affairs (Defra), 'UK Air quality limits' and World Health Organisation (WHO), 2021, *WHO global air quality guidelines*
[18] North Lincolnshire Council, 2023, *op cit*
[19] Defra UK Air Information Resource, 'Effects of air pollution'; Public Health England Guidance, 14 November 2018, 'Health matters: air pollution'
[20] Public Health England guidance, 7 August 2018, 'Polycyclic aromatic hydrocarbons (Benzo[a]pyrene): general information'
[21] CREA, 2023, *op cit*
[22] National Institute for Public Health and the Environment of the Netherlands, 2023, *The contribution of Tata Steel to the health risks of local residents and the quality of their surroundings*
[23] Global Efficiency Intelligence, 2022, *Air pollution from global steel industry: an international benchmarking of criteria air pollutants intensities*
[24] Green Alliance analysis of National Atmospheric Emissions Inventory point sources dataset, 2021. This includes both observed and modelled data, to fill gaps in monitoring data and provide as full a picture as possible of emissions from all sites.
[25] L Wei et al, 2019, 'Life cycle energy consumption and greenhouse gas emissions of iron pelletizing process in China, a case study', *Journal of Cleaner Production*, 233, 1314-1321.
[26] J Bolen, 2024, 'Modern air pollution control for iron ore induration', *Mining, Metallurgy & Exploration*, 31, 103-114
[27] M Saikat et al, 2022, 'Impact of heavy metals on the environment and human health: novel therapeutic insights to counter the toxicity', *Journal of Kind Saud University – Science*, 34 (3), 101865.
[28] L Xiaoling et al, 2018, 'Material metabolism and environmental emissions of BF-BOF and EAF steel production routes', *Mineral Processing and Extractive Metallurgy Review*, 39:1, 50-58. The National Atmospheric Emissions Inventory (NAEI) estimates air pollutant emissions by compiling and analysing data provided by regulators and industry, including through the Pollutant Release Transfer Register (PRTR) and national energy statistics. This data is used as one of the inputs for spatial modelling of pollutants for the NAEI point sources dataset.
[29] NAEI, 6 July 2023, *UK spatial emissions methodology*
[30] The Air Quality Standards Regulations (2010) in England and associated regulations in other home nations.
[31] Department for the Environment, Food and Rural Affairs (Defra), 2023, 'Air quality objectives update'. This was enacted through section 2 of the Environment Act 2021.
[32] World Health Organization (WHO), 2021, 'WHO global air quality guidelines'

[33] Defra, 2023, ‘Air quality objectives update’
[34] WHO, 2021, op cit
[35] X Bo et al, 2021, ‘Effect of strengthened standards on Chinese ironmaking and steelmaking emissions’, *Nature Sustainability*, 4, 811-820.
[36] Centre for Research on Energy and Clean Air (CREA), 2023, op cit
[37] The air emissions limit for dust from electric arc furnace steelmaking in China’s ultra-low emissions standard is 10 mg/m³ (see: Ministry of Ecology and Environment of the People’s Republic of China, 2019, *Opinions on promoting the implementation of ultra-low emissions in the steel industry*). The EU BAT-associated emission levels for dust from electric arc furnace steelmaking are 5mg/m³ for dedusting and 10-20 mg/m³ for on-site slag processing (see: Industrial emissions Directive 2010/75/EU : integrated pollution prevention and control, 2013, *Best available techniques (BAT) reference document for iron and steel production*). Green Alliance analysis compares the highest end of range for the EU against China’s standard, as evidence from CREA suggests, the upper end of limits are adopted by industry in the EU to comply with BAT (see: CREA, 2023, *Upgrading Europe’s air: how a strong industrial emissions directive can save lives and money).*
[38] CREA, 2023, op cit
[39] EU Commission, ‘Industrial and livestock rearing emissions directive (IED 2.0)’
[40] Defra, 31 December 2020, ‘Industrial emissions standards and best available techniques’
[41] Defra, 20 December 2022, ‘Establishing the best available techniques for the UK (UK BAT)’
[42] House of Commons Library, 19 February 2024, *Air quality: policies, proposals and concerns*
[43] Welsh Government, ‘Interim environmental protection assessor for Wales’
[44] Welsh Government, 30 January 2024, ‘Environmental principles, governance and biodiversity targets: white paper’
[45] Office for Environmental Protection, June 2022, *Strategy and enforcement policy*
[46] EU Commission, 26 October 2022, *Proposal for a revision of the Ambient Air Quality Directives*
[47] Public Health England, 22 May 2018, ‘New tool calculates NHS and social care costs of air pollution’
[48] Environment Agency, 21 August 2024, ‘General guidance: pollution inventory reporting’
[49] If the steel 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. See Green Alliance, 2022, *Building the future: a faster route to clean steel*