Economic benefits of industrial decarbonisation

A low carbon industrial future for the UK

September 2023

A WPI Economics Report for Aldersgate Group

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Our focus is on important social, environmental and economic policy debates, such as the future of the green economy, productivity and growth, levelling up and mental health. We are driven by a desire to make a difference, both through the work we do and by taking our responsibilities as a business seriously. We are a Living Wage employer, currently working towards BCorp accreditation.

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Executive Summary

Net zero is the business opportunity of the 21st century, and an increasingly competitive one. The US, European Union, and China have all implemented bold policy and investment measures designed to secure a major share of the global market for green goods. The UK has yet to fully set out its response to this opportunity. This paper focuses on one critical element of this response - the ambitious package of interventions needed to deliver a competitive and low carbon industrial base in the UK.

The UK has made significant progress on reducing industrial emissions. However, much of this happened as the sector has declined rather than by decarbonising industrial processes. As this paper outlines, these industries play a critical role in our economy and society, and are vital to us seizing the green growth opportunity of the future. The UK's foundation industries provide high skilled employment in communities across the country, deliver important strategic and resilience benefits, and support a wider complex chain of sectors and activities. The Government needs to use policy to propel these sectors into producing green products so that they can continue to deliver these benefits into the future. Deindustrialisation would be a fatal error, and it is therefore vital the Government can put in place the policy response to secure a positive future for our low carbon industries.

Our analysis shows that **our industrial sectors and wider supply chain contribute £152 billion in GVA to the UK economy and support over 1.4 million jobs.** Many areas rely strongly on industry to support jobs and economic activity, with industry jobs tending to pay more than region averages. Today, 28% of total heavy industry GVA is in the North alone, bringing nearly £43 billion and over 400,000 jobs to the local economies. A further £29 billion and 290,000 jobs in the Midlands shows how important avoiding deindustrialisation is to the levelling up agenda within England's regions. Scotland's (£18 billion and 138,000 jobs) and Wales' (£10.5 billion and 121,000 jobs) economies also benefit greatly from heavy industry. **Every one direct job in industry creates more than 2 across the economy, in indirect and induced jobs**.

Furthermore, **new analysis for this report shows that many UK industries start from a strong position of comparative advantage globally.** This includes chemicals, non-ferrous metals, and beverage manufacturing. **Overall, UK industry makes up around 21% of the UK's exports, compared to 22% globally**. In addition, we have a series of nascent sectors in the form of Hydrogen and Carbon Capture, Utilisation and Storage (CCUS). New analysis for this report shows that **businesses in these emerging green sectors turnover £1.7bn across the UK and are expected to grow at a rate of 20% per year**

In order to seize the global net zero opportunity, our foundation industries will need to achieve 'deep decarbonisation' to compete with low carbon industry in other countries. Depending on the sector, this is a combination of energy and resource efficiency, fuel switching, and carbon capture technologies. All of these require significant investment and policy support. **New analysis for this report sets out the cost to the UK of failing to provide this support:**

- Looking to the future, in the extreme case of providing no further support for heavy industry's net zero transition, our model forecasts that the sector's share of national GVA would collapse from 6.4% in 2022 (including direct, indirect and induced GVA) to merely 0.3% in 2050.
- In the most optimistic scenario, heavy industry is maintained at 6.2% of national GVA in 2050 at over £235bn.

This means **providing no further support for decarbonising industry is equivalent to wiping out nearly £224bn (in 2022 prices), or 5.9% of total GVA in 2050** compared to the investment option.

As this report sets out, there are significant benefits to the decarbonisation of industry without deindustrialisation. In order to unlock these benefits, the **Government must commit to a long-term industrial strategy that brings together a series of key interventions:**

- **A clear plan for industrial decarbonisation** – including clarity on decarbonisation pathways for UK industry sectors, priorities for usage of limited technology like hydrogen and CCUS, and investment in the required infrastructure.
- **Making electricity prices more competitive for UK industry** – by rebalancing policy costs from electricity onto gas over time and introducing voluntary Contracts for Difference.
- **Reforming the UK ETS and introducing a carbon border adjustment mechanism (CBAM)** – linking the UK ETS to the EU's, introducing a UK equivalent of the Market Stability Reserve, and introducing a CBAM no later than 2026
- **Consideration of a cluster policy** which makes the most out of existing clusters whilst also considering the challenges faced by dispersed sites

CHAPTER 1

UK Context for Industrial Decarbonisation

The UK has been a frontrunner in decarbonisation, being the first country to pass legislation committing to a net zero target. It has also had the fastest rate of decarbonising manufacturing in the G7, having reduced emissions by 54%[1] since 1990. However, in the same period of time, there has been a 47% fall in manufacturing jobs. This shift is partially because some of the UK's carbon-intensive industries have been moved overseas. While the UK has ambitious net zero targets, there is a real risk that its emissions reduction targets in industry are being achieved through deindustrialisation rather than decarbonising industry.

While decarbonising industry is a significant economic, operational and technological undertaking, it will also deliver a range of economic, social and strategic co-benefits. For example, our analysis shows that:

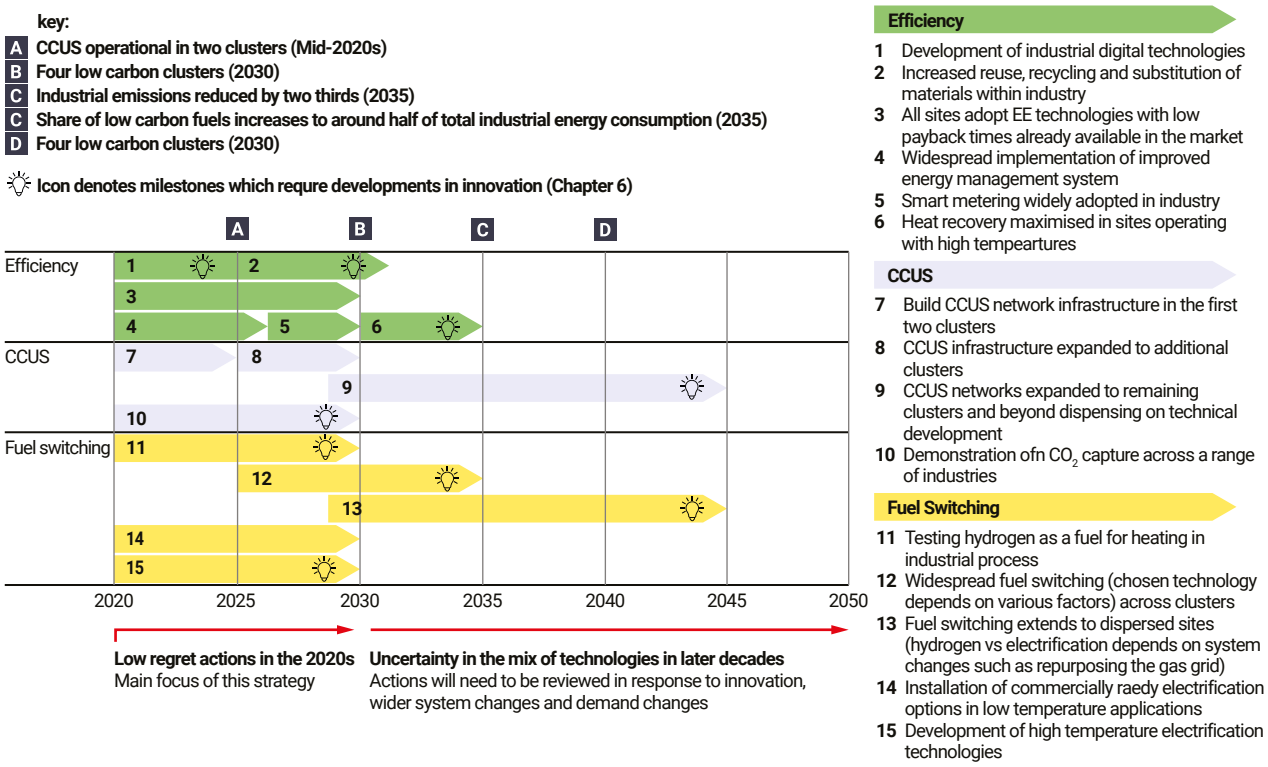
- Industry contributes over £150 billion in direct, indirect, and induced GVA to the economy.
- Overall, UK industry makes up around 21% of the UK's exports, compared to 22% globally.
- For every one direct job in our industry sectors, there are two other jobs in the wider economy.

Heavy industry also closely supports the UK economy, including by the providing the materials required for critical and strategically important activity such as transport and defence. As a result, decarbonisation of UK industry is therefore a necessity as well as an opportunity going forward.[2]

UK's industrial decarbonisation goals

The Balanced Pathway scenario of the CCC's Sixth Carbon Budget sets out to achieve a high rate of decarbonisation through the 2020s to mid-2030s through the use of new technologies, resource and energy efficiency, fuel switching and the development of new infrastructure. The Government's industrial decarbonisation strategy summarises how these different technologies have different roles in the decarbonisation pathway to 2050:

Figure 1: Industrial decarbonisation strategy



Source: Gov.uk[3]

The following sections discuss the mix of measures and technologies which will help to decarbonise industry over the coming decades, starting from a cross-sector perspective, as well as sector-specific considerations.

Cross-sector decarbonisation challenges

In future, industrial decarbonisation will rely on new technologies that are currently in initial stages of development or have not been deployed at a commercial level. Furthermore, many of them do not have commercially viable implementation models, making them expensive for companies to adopt. This could increase costs and damage competitiveness, resulting in carbon leakage that is detrimental to the industry and workforce in the UK.

However, currently several gaps in the policy and regulatory framework for industrial decarbonisation, with many areas in need of action. In particular:

- UK electricity prices can make decarbonisation expensive (whether by electrification, CCUS, or green hydrogen), both in absolute terms and relative to other European countries.
- There is a need to create demand-side pressures that help to stimulate business investment in decarbonisation, e.g., through Mandatory Product Standards (MPS).
- Industry needs access to finance as investors are hesitant to back new technologies that have unknown payback periods. This is particularly difficult given the sheer scale of investment required, such as the estimated £3 billion to decarbonise a blast furnace.
- Research and development efforts need to be accelerated as many areas, like resource and process efficiency, need further study.
- Competition from cheap but high carbon imported goods.

The geographical distribution of the UK's industry comprises clusters and standalone or 'dispersed' sites. Clusters are comparatively easier to decarbonise due to economies of scale. However, decarbonising dispersed sites is challenging. This is particularly concerning as almost half of industrial emissions in the UK come from dispersed sites.[4]

Heavy industry in the UK

Heavy industry sectors form the backbone of the UK's industrial landscape. Not only are they integral in terms of the value they create for the economy, but also in their enablement of other sectors' success. Some are strategically important to the UK due their contribution to defence and energy security. Most of these sectors are energy-intensive and result in high emissions. We define heavy industry sectors as either being above 25 tCO2e per person per year, or historically labelled as heavy industry.

The heavy industry sectors are also essential drivers of trade for the UK, with six out of 14 sectors having a revealed comparative advantage according to our analysis. Heavy industry represents 21.2% of total UK exports, very much in line with the global average of 22.6% of total global exports.[5]

Key trading sectors such as beverages tend to have a strong presence in areas identified by the Oxford Economics Green Growth Index as areas with a high balance of opportunity over challenges. Strengths include an existing base of green economy activity (particularly in the energy sector) as well as access to a workforce with relevant skills for the green transition, and significant R&D activity in other areas. Existing trade performance is also likely to be boosted in the future, with all heavy industry sectors able to leverage their relative balance of opportunity over threat to develop a future trade advantage, even where there currently isn't one.

For the purpose of this study, five foundation sectors were chosen for a deeper analysis. The chosen sectors are cement, steel, chemicals, glass and ceramics.[6] These industries have deeply interconnected supply chains that touch upon almost all manufacturing sectors in the UK, which are explored more deeply later in the chapter. Due to this complex interconnectivity, decarbonisation efforts in these five sectors will have an exponential impact on the net zero journey of the wider industrial landscape of the UK.

Decarbonising cement

Cement is a high carbon sector, and its manufacture produces 36%[7] of all construction-related emissions owing to its use in making concrete, comprising 10-15%[8] cement by volume. Concrete is the most widely consumed material on the planet, second only to water. It accounts for up to 8% of total global and 1.5% of UK CO2 emissions.[9] Housing, roads, schools, hospitals, dams, ports and other engineering structures are all constructed using concrete. The country produces over 95%[10] of its needed concrete.

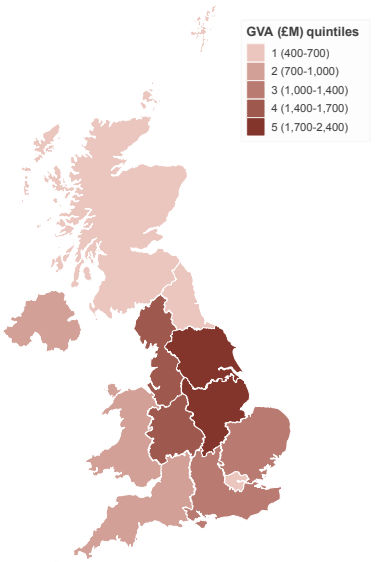
Figure 2: Cement Sector Profile

£14,381
GVA total (£m) (2022)

29,368
Direct jobs (2022)

107,736
Total jobs (2022)

9.22
Co2 (mt) in 2020



Cement, lime and plaster
GVA (£m)

Cement, lime and plaster
Employment (FTE)

Source: Cement - WPI Economics analysis and CCC

The cement sector directly employs approximately 1,100 people in Great Britain[11] (providing high-wage, high-skilled jobs, often in remote areas like the Peak District with few competitive employment alternatives) and contributes approximately £171million in GVA.[12] The numbers are even greater for the wider industry that includes lime and plaster, providing over 29,000 jobs and GVA of 14 billion (direct and induced).

The manufacture of cement, lime and plaster combined represents only 0.03% of total UK exports and is not presently a comparative advantage for the UK. However, importing cheaper cement products is an increasing threat to the sector and the supply chains of essential domestic sectors such as construction. Cement imports had been steadily rising at around one percentage point a year over the last two decades, but this has accelerated in recent years with imports in 2021 jumping up four percentage points and a similar increase seen in 2022, which resulted in 30% of the UK cement market being met through imports. Our analysis of future trade suggests that, on balance, the opportunities are narrowly greater than the challenges for the cement sector in the UK. As such, this sector is likely to only see gradual improvement in export performance; however, its strategic importance more than justifies long-term investment in the sector to avoid relying on imports due to an erosion in competitiveness.

Why decarbonise?

The UK can potentially become self-sufficient in manufacturing cement and concrete due to an abundance of key geological raw materials. The construction industry is a key driver of growth, and the demand for housing, infrastructure and public buildings is always increasing. UK concrete is known for its high quality with over 90%[13] being certified as 'very good' or 'excellent' by the 'BES 6001 Responsible Sourcing of Construction Products' framework.

The UK cement industry has already invested considerable resources towards decarbonising the sector through adopting new technology, replacing key raw materials with lower carbon alternatives and partially switching from traditional fossil fuels to biofuels derived from waste, which now account for 45%[14] of all fuel used. One such example is Climafuel, which is made using household residual and commercial waste.[15] This not only helps cut emissions from the cement sector, but also contributes indirectly to sustainability efforts by diverting waste away from landfills.

Decarbonisation challenges

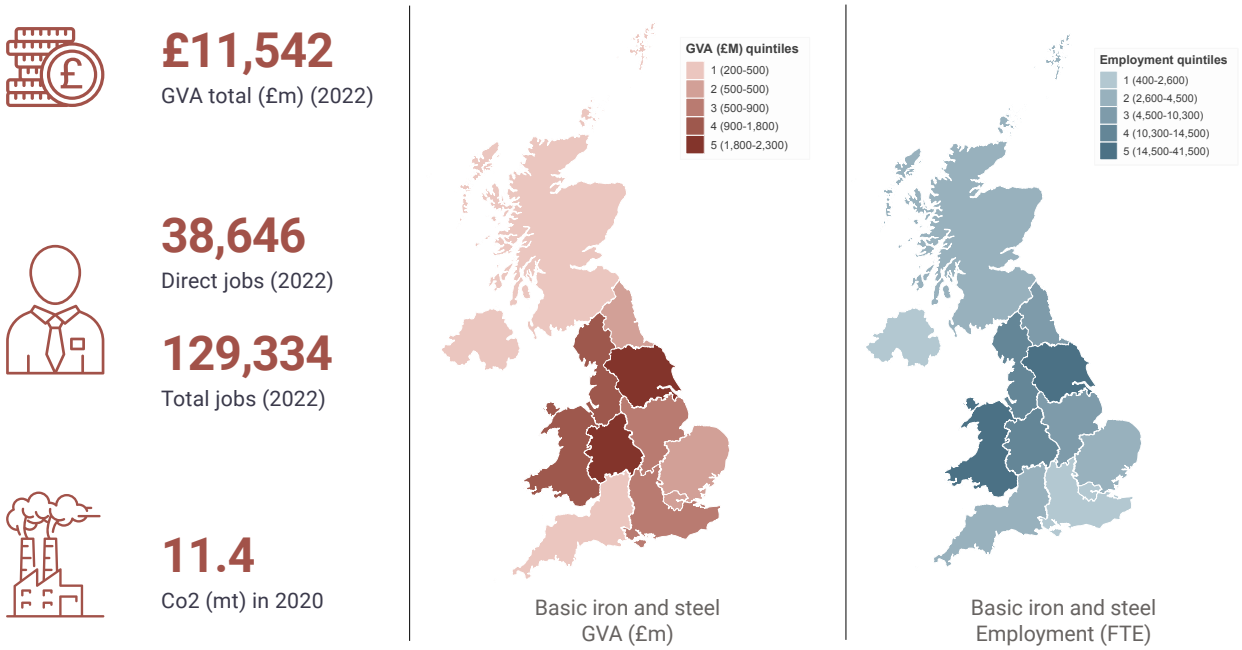
Like most heavy industries in the UK, the cement sector has a mix of generalised and unique challenges when it comes to decarbonising. Most emissions are produced during the calcining stage of the cement manufacturing process when the decomposition of limestone or calcination occurs, representing 2/3rd[16] of the total emissions. This makes decarbonising cement particularly challenging as switching energy sources will not change process emissions. Another pertinent challenge for decarbonising cement in the UK is the geographical spread of production sites, many of which are located away from clusters and near areas of natural beauty. Currently, the Government's decarbonisation focus is concentrated in two industrial clusters in North West England and Wales and the East Coast; however, 50% of emissions are caused by production sites outside these clusters.[17] As CCUS is the only viable decarbonisation option at the moment[18], it exhibits a number of challenges in the form of building CCUS infrastructure that serves only one site and higher transportation costs.

The costs for implementing decarbonisation technologies are very expensive for the cement sector, with required investments falling in the range of £170-250 million pounds[19] per kiln. This will have a direct impact on the price of cement, which is estimated to increase by 50 to 100%.[20] Another challenge is a lack of investor confidence in backing the fairly new technologies required to deploy decarbonisation, especially at the scale necessary for effective results. This is compounded by the lack of plans/policy at a national level for hydrogen transport, increasing electrical grid capacity and CO2 transport and storage infrastructure. Investors are also cautious of being locked into unsuitable investment choices due to the high capital costs of decarbonising technology, plants and other infrastructure and long investment cycles. A lack of suitably qualified engineers and those with specialised skill sets adds to the challenge.

Decarbonising steel

The UK steel industry has been playing a steady role towards decarbonising the sector over the past three decades, having reduced emissions by 58%[21] since 1990. So far, the significant reductions in emissions from the steel sector have been achieved through closure of blast furnace operations as opposed to greening and maintaining operations. Current emissions in the UK are mainly produced by two industrial sites in Scunthorpe and Port Talbot in South Wales, accounting for 95%[22] of total sectoral emissions in 2017.

Figure 3: Steel Sector Profile



Source: Steel - WPI Economics analysis and CCC

Whilst the iron and steel sector does not hold a comparative advantage when compared to exporting giants in the steel market, such as China and Germany, 45% of UK production is exported, making it a significantly trade-exposed sector at risk from subsidies in the EU and US. Nonetheless, the sector still makes up 1.24% of total UK exports despite being relatively disadvantaged by higher energy costs. With our analysis showing a net positive in terms of opportunities for green growth in the sector over challenges, further investment (particularly in bringing down energy prices) could supercharge existing opportunities into a trade advantage in basic steel in the future. It is also worth noting that, according to our analysis, manufacturers of steel do hold an international comparative advantage, so investing into the local basic steel industry will also protect the supply chain of an existing trade advantage. These are specialist steel products which are competitive globally because of meeting specific requirements from a variety of sectors, and this advantage is only likely to strengthen as green markets demand more specialist products.

Why decarbonise?

The UK steel industry in a precarious position. It is a relatively small sector for the economy but plays a crucial role strategically. Steel is a raw material in a myriad of industries that are economically, strategically and socially important for the country - including construction, defence, energy, transport, nuclear, machinery and engineering, among others. It is particularly important in the country's transition towards net zero as it is used in wind turbines, electric vehicles, rail networks and low carbon buildings. Currently, steel has a high risk of decarbonisation by deindustrialisation.

Decarbonisation challenges

Steel is considered hard to decarbonise as there are commercial barriers such as long investment cycles and high energy use in processes.[23] There is a significant need for government assistance in the UK steel industry because of the barriers.[24]

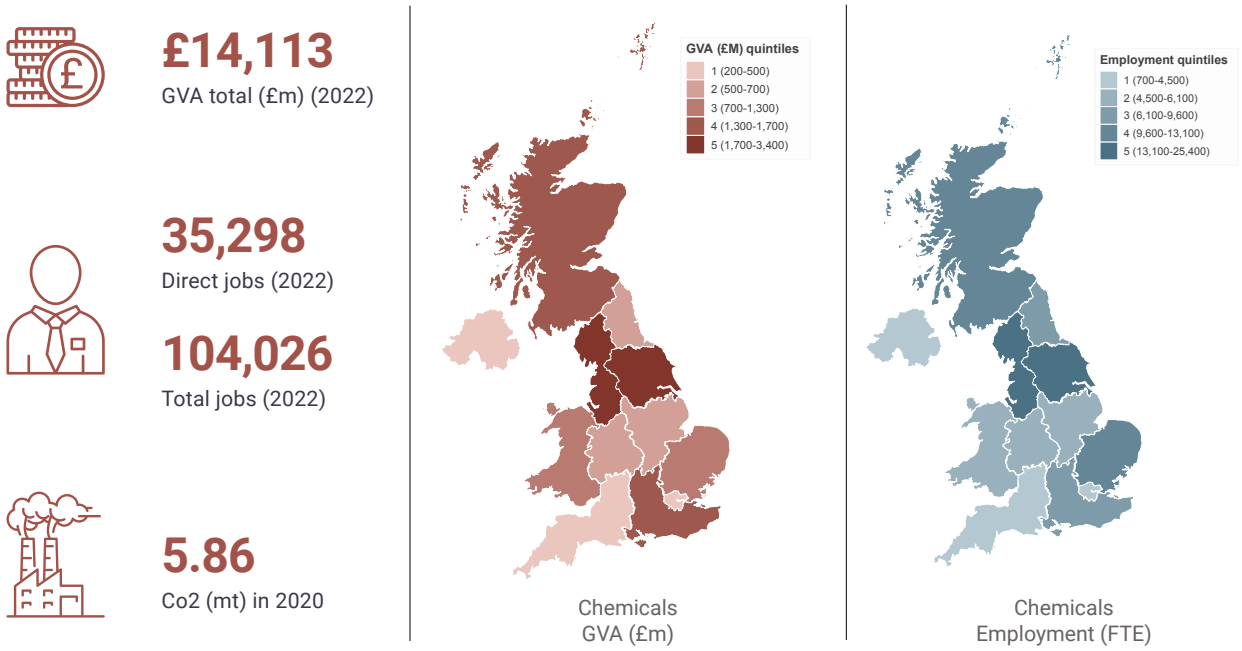
The UK has some of Europe's highest industrial electricity prices, about 61% higher than Germany and 51% more than France.[25] This makes switching to net zero steel making cost intensive as all net zero steel production (electric arc furnaces, CCS, and hydrogen steel production) are more electro-intensive than current production methods.

Decarbonisation of steel will also require some training and upskilling of the workforce associated with production. However, we have heard from stakeholders that these are secondary to other considerations, such as energy prices. .

Decarbonising chemicals

The chemicals sector is one of the most important industrial sectors globally and in the UK specifically. It is of great strategic and economic importance - as much as 96%[26] of all production needs chemicals in some form, which means that decarbonising the sector will have an exponential effect on global manufacturing emissions. In the UK, the sector provides 2% of GDP and 10% of the manufacturing industry's GVA.[27] As a sector it is a major exporter, with 63%[28] of the UK's chemical products being exported.

Figure 4: Chemicals Sector Profile



Source: WPI Economics analysis and CCC

The chemicals sector has a potential comparative advantage which can be nurtured into a green exporting strength for the UK. The wider sector represents a huge chunk of UK exports, at 8.55% of total export value, with a massive £40billion a year average between 2018 and 2022. Facing more opportunities than challenges according to our Future Growth index, we would also expect this already strong trade performance to strengthen slowly over time. Representing a foundational supplier for so many diverse industries, nurturing this domestic industry is essential not only to continue to build on its exporting strength, but also to avoid having to rely on imports and the resulting risk of supply chain disruption.

Why decarbonise?

The UK has an early mover advantage when it comes to decarbonising the chemicals industry. Chemicals manufactured in the country emit lower emissions than those produced in many other countries, due to the feedstock used in the process.[29]

The chemical industry supports critical technologies in the transition to net zero, it is an important source of raw material for batteries, heat pumps, insulation and wind turbines. It is also an opportunity for the industry to bring certain sectors like ammonia into the net zero process. For instance, ammonia manufactured with zero emissions can potentially be used as a low carbon source of shipping fuel or for energy storage. Hence, decarbonising the chemicals industry will have significant wider impacts on achieving net zero as a whole.[30]

The industrial clusters and production sites are mostly located outside London and the South East, making it an important sector for mitigating regional inequalities through the jobs it creates. Moreover, the workforce of the chemical industry is typically high skilled, making it an important source of high-value jobs.

Decarbonisation Challenges

Since chemicals is a vast sector, there is understandably a gap in the research, development and demonstration of new technologies that are essential for decarbonisation. There have been developments in the reduction of process emissions as well as using alternative fuels for production. However, this has not successfully been deployed at commercial level. It is also expensive and many companies are not focused on furthering R&D in the field as the return on investment on the time and resources spent is not guaranteed.[31]

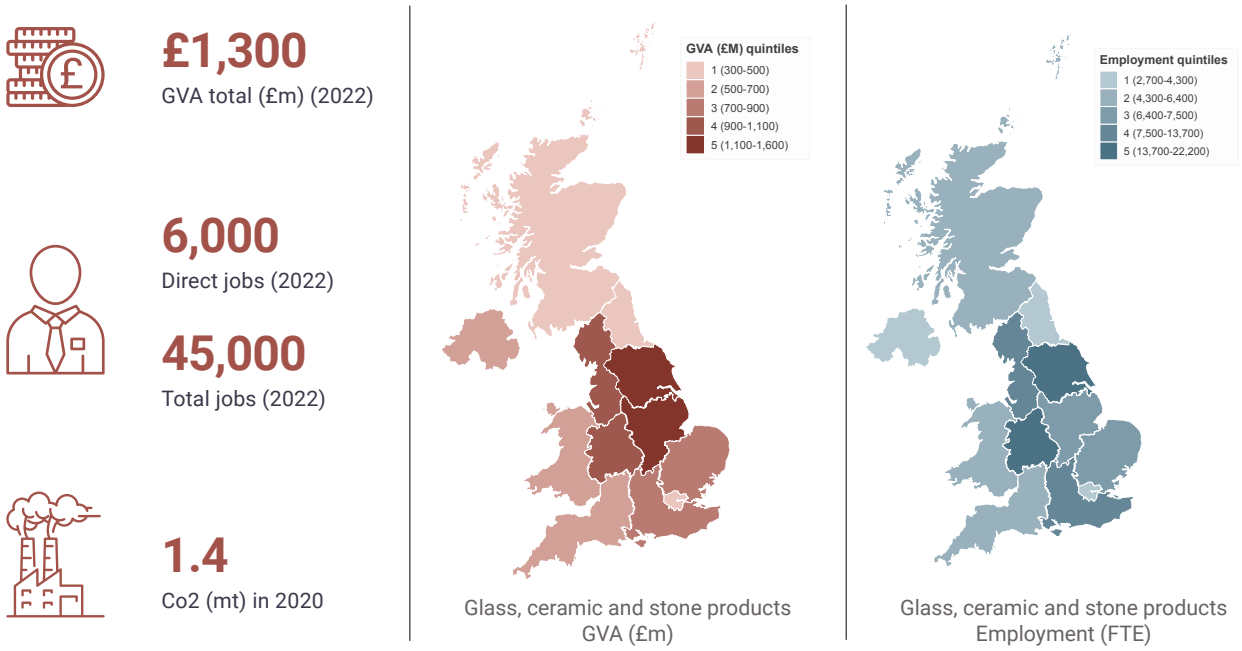
There is a need to build shared infrastructure, which may be challenging for some standalone plants due to geographical isolation. Industrial clusters too have unique challenges in establishing shared infrastructure as collaboration between companies is difficult to achieve. Absence of policy and incentives in this case makes it all the more challenging.[32]

The chemicals sector has a need for a highly skilled workforce and a lot of investment is needed in skills training and recruiting the right candidates. There has been a shortage of qualified workers in the past and the sector still struggles to find appropriate employees.[33] The uncertainty associated with the skills needed to decarbonise and the new technical requirements that may emerge will be a significant issue for the already limited workforce.[34]

Decarbonising Glass

The glass sector comprises of container glass (bottles and jars), flat glass (windows for construction industry), fibre glass (used in wind turbines and lightweighting of vehicles), glass wool (used for insulation) and specialty glass products (e.g., lighting; oven hobs; and those for optical, medical and scientific uses). Glass manufacturing uses high temperature melting furnaces and other heat intensive equipment that consume 85%[35] of all energy in the process, mostly natural gas.

Figure 5: Glass Sector Profile



Source: British Glass and Griffin et al (2021)

The glass, ceramics and stone products are a relatively small percentage of total UK exports at only 0.66% combined but glass itself is a relatively trade exposed sector. Given how essential many glass products produced in the UK are to domestic supply chains, protecting this industry from subsidised trade competitors is essential to ensuring this strong trade balance continues. Whilst our analysis finds that this sector is not currently a comparative advantage for the UK, the balance of opportunity over threat in terms of green growth is a net positive for this sector, so trade performance is likely to strengthen over time. In particular, growing demand from green markets for first-of-a-kind tech and projects is likely to

grow local specialties and therefore new export strengths. The Encirc and Diageo factory, for example, is set to create the world's first net zero glass bottles.

Why decarbonise?

Glass is an essential component of multiple industries like automotive, construction, packaging, green energy, medicine, and semiconductors. It has demonstrated applications in many emerging sectors - continuous filament fibreglass is a key component for manufacturing wind turbine blades, while flat glass is important in solar technology. In addition, glass has a crucial role to play in decarbonising other sectors by potential carbon savings. If all buildings in the UK were to update their glazing to high-efficiency glazing by 2030, it would create an estimated 32%[36] drop in energy consumption in buildings. The use of glass in vehicles has the potential to reduce transport emissions by reducing the weight of vehicles. Continuous filament glass fibre, a composite material used in the reinforcement of thermosetting and thermoplastic resins, can aid emissions reduction in the automotive industry by reducing vehicle weight, leading to increased fuel efficiency. Glass fibre is also integral towards green energy production, with products made with glass fibre resulting in the construction of wind turbine rotor blades that are longer, lighter and more efficient.

Decarbonisation challenges

Glass is produced in furnaces that melt the required raw material, often running continuously for 'campaigns' of 10-15 years. This is a high-energy process which, given the high cost of industrial electricity in the UK, is not affordable if completely electrified. The energy cost for electric furnaces is three times that of natural gas for a standard glass furnace, and upgrading them will cost an additional £12 million[37] per site. It is not commercially feasible to switch to electric energy with current available technology. At the moment, small electric furnaces are only used to produce higher value products such as glass tableware.[38]

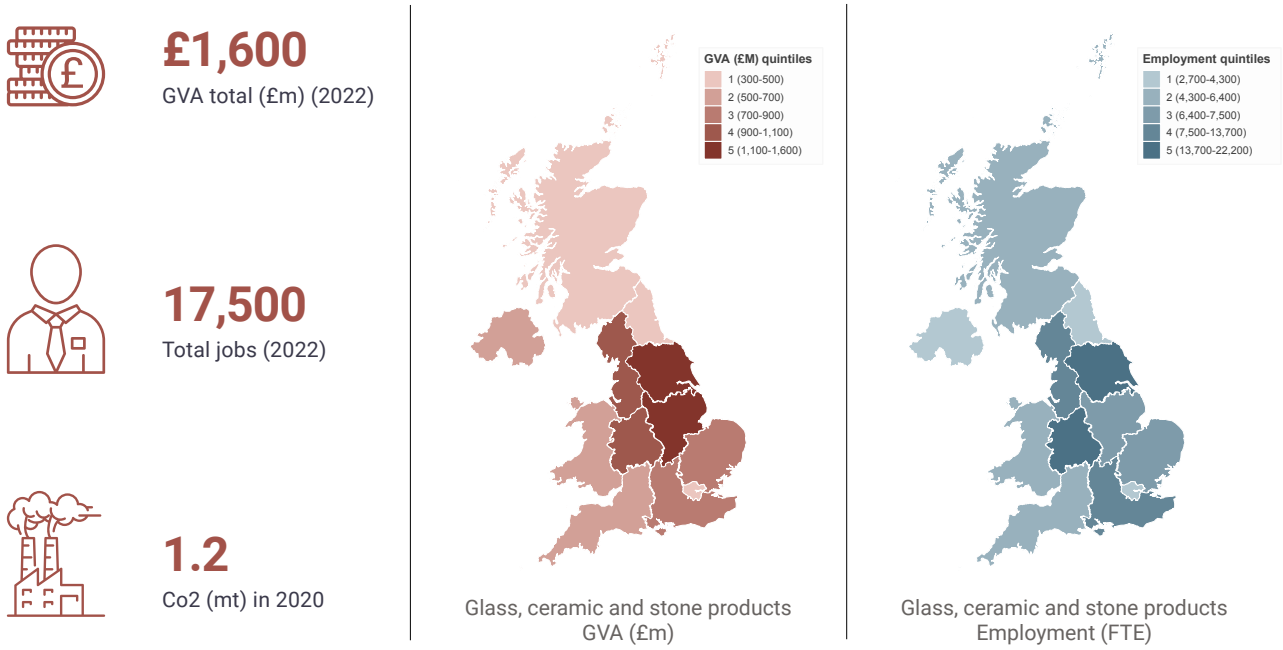
A furnace is usually rebuilt after two campaigns. Any decarbonisation measures must wait until after a campaign has ended. The extended period required to convert furnaces will have an impact on industry output. The UK's glass furnace assets are valued at approximately £1.4 billion[39], and closing them for extended periods will be detrimental to the glass industry and other sectors that depend on glass as a key raw material.

Decarbonising ceramics

The UK ceramics industry encompasses a vast array of long-life goods, from well-known products to cutting-edge materials, all with a range of unique durability, mechanical, thermal, electrical, and biochemical properties. Product diversity ranges from clay construction products such as bricks, roof tiles, drainage pipes, wall or floor tiles, sanitary ware, household goods like tableware and giftware, to more advanced products like high-temperature refractories (used in all foundation industries and power generation) or technical ceramics (with uses spanning transport, defence, aerospace, medical, to name a few).

The UK ceramics industry has been progressively decarbonising over many decades, with industry consolidation, fuel-switching and significant efficiency improvements reducing emissions by around 50% since 2003.[40] Over the last decade alone the UK sector has self-invested over £750 million and has some of the world's most energy- and carbon-efficient ceramic manufacturing operations.

Figure 6: Ceramics Sector Profile



Source: British Ceramics Confederation

With an export value of £0.6 billion, the ceramics sector is relatively trade exposed and, similarly to the glass sector, is essential for many domestic supply chains. This challenge is further compounded by energy cost pressures, with overseas competitors often facing much lower energy prices for the same goods, putting pressure on domestic businesses from imports. Given the sector's importance to the green transition, support is essential to avoid reliance on imports (and therefore risk of supply chain disruption) in the future. Despite the current lack of international comparative advantage for the glass, ceramics and stone products sector, the positive balance of opportunity over threat in the green economy, and likely growth in demand for specialty ceramics products from the global green transition could see this reversed with further investment and support for the sector.

Why decarbonise?

Ceramics is a strategically important UK industry as its products touch on all areas of the economy and underpin many areas of the net zero transition, such as in the built environment, industry, power generation and transport. As listed above, applications in which ceramics are used are broad-ranging and often unexpected, but products are often critical components in highly demanding applications.

Decarbonisation challenges

The UK ceramics industry is one of the hardest to decarbonise as it faces many technical and commercial barriers, and further sectoral characteristics will impact its continued decarbonisation[41] including:

- A large number of dispersed production sites located away from industrial cluster areas
- Comparatively smaller-scale site emissions versus many other foundation industries
- A majority of SME companies with limited resources
- Process emissions (mostly from clays/additives) making up a large proportion of emissions
- Breadth of production processes and products.

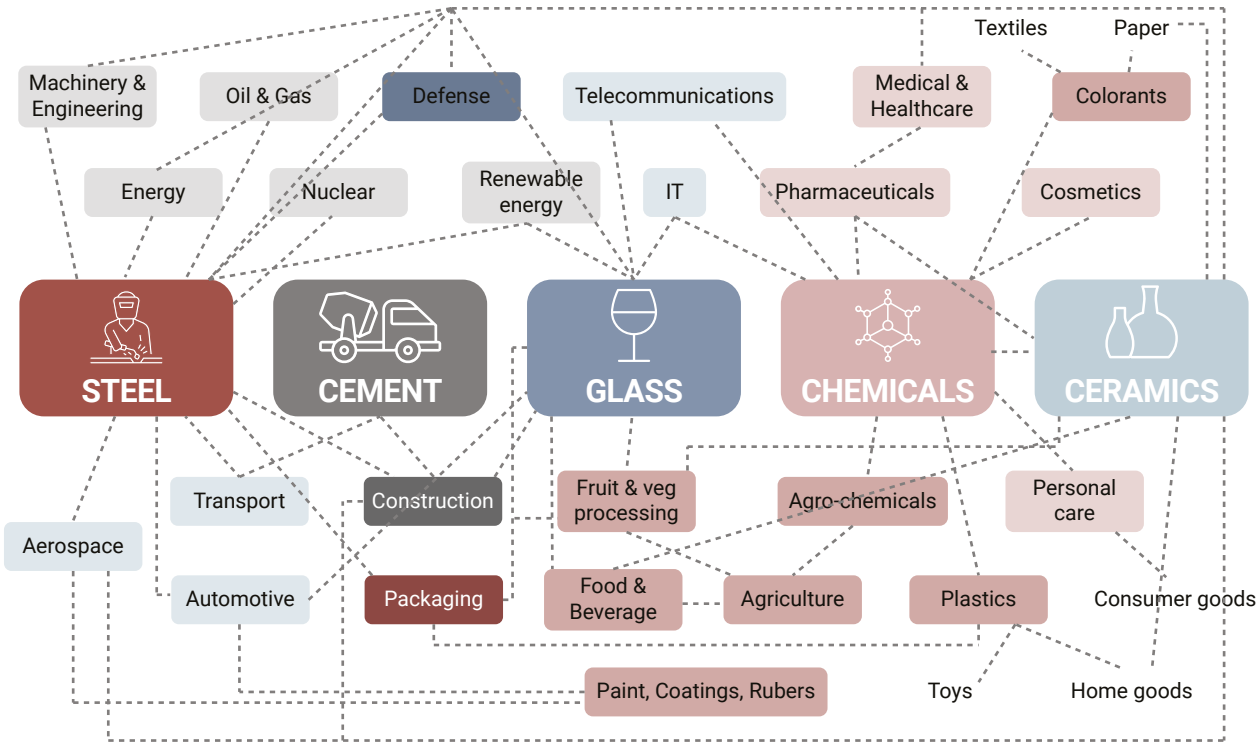
All ceramic businesses compete in fiercely competitive global markets and rely on being internationally competitive versus overseas producers. Ceramics is one of the most energy-intensive sectors due to firing products at high temperatures (above 1,000 °C). Energy and climate costs have historically represented up to 30% of total production costs but can now exceed 65% given recent price surges. It is also labour-intensive, accounting for up to 25-30% of production costs.[42]

Investment in key ceramic manufacturing equipment (kilns/dryers) is capital-intensive and with long operational lifespans, typically up to 30-40 years.[43] This means that whilst there may only be one or at most two investment cycles before 2050 (limiting opportunities for full-scale upgradation), retrofitting of existing kilns may also be necessary. Most producers have kilns from different periods that have undergone improvements at separate times.

The sector's diversity also reflects the breadth of necessary decarbonisation technologies, including low-carbon hydrogen, electrification, Bioenergy with Carbon Capture and Storage (BECCS).

Heavy industry supply chain impacts

Figure 7: Interdependency of heavy industries' supply chains



Strategic value and resilience

Steel, cement, ceramics, chemicals and glass are some of the foundation sectors of the UK's industrial landscape. They are essential for most other industries and manufacturing sectors in the country and ensure the smooth functioning of our economy. All these heavy industries have complex supply chains which are interdependent on each other and other industries. Cement, steel, glass, ceramics and chemicals are integral to the construction industry, which allows us to build housing, hospitals, school infrastructure, transport networks and service infrastructure necessary for economic growth and prosperity. These sectors also play a big role in the energy sector - fossil fuel based and renewable, which form the backbone of every other industrial and economic activity. Glass, chemicals, steel and ceramics are important for the sectors of advanced manufacturing, digital technology, life sciences and green industries - which the Chancellor identified as priority growth sectors in 2023.[44]

The recent example of the COVID-19 pandemic has really brought home how essential these foundational industries are for the resilience of the domestic supply chain. The automotive sector, with many just-in-time processes, benefits enormously from domestic steel supplies, for example, through increased resilience to supply disruptions such as the pandemic, as well as added flexibility in making changes to production lines. There was plenty of evidence during the pandemic that sectors with localised supply chains suffered less disruption to activity. In contrast, those particularly reliant on Chinese imports, such as the construction industry, saw activity paused or even stopped. One long-term impact of the pandemic was a certain level of reshoring of activity, with the globalised supply chain model having seen its first significant challenge since the 80s.

Importance for net zero

As with most other industrial sectors, the renewable energy and low carbon manufacturing sectors rely on the foundation industries for the supply of raw materials. Steel is used to manufacture wind turbines, rail networks for low carbon transport and electric vehicles.[45] Glass fibres and flat glass are used to make wind turbine blades and in the production.[46] Chemicals are perhaps most vital as they are integral to most green energy technologies[47], from heat pumps and insulation to batteries, wind turbines, solar panels, and low carbon fuels . Ceramics are essential to building manufacturing equipment that allows the high temperature processes necessary for many industries, including glass and steel . Heavy industries are, therefore, an irreplaceable part of the road towards net zero, making it all the more crucial for the UK to decarbonise and retain these industries. Longevity of these sectors is also essential to further renewable and low-carbon energy which will ensure energy security for the country.

Regional welfare and prosperity

Heavy industries in the UK are located in industrial clusters (e.g., Grangemouth, Merseyside, Humberside, South Wales) or across scattered sites in rural areas. Therefore, they are significant in closing regional inequalities by creating jobs away from London and the South East, typically paying salaries higher than regional and national averages.[48] Apart from increasing employment opportunities - both skilled and non-skilled, the presence of industries brings many direct and indirect advantages. They create an ecosystem of knowledge, innovation and skills development through their spillover effects. They have a role to play in improving transport and communication infrastructure in the long term. Most importantly, local residents benefit from the region’s success with increased prosperity and access to better services. Decarbonisation by deindustrialisation risks stripping such regions not just of employment, but also the myriad of community benefits that the presence of these ‘anchor industries’ brings. This will also directly impact the success of the Government’s Levelling Up Agenda by fuelling regional inequalities.

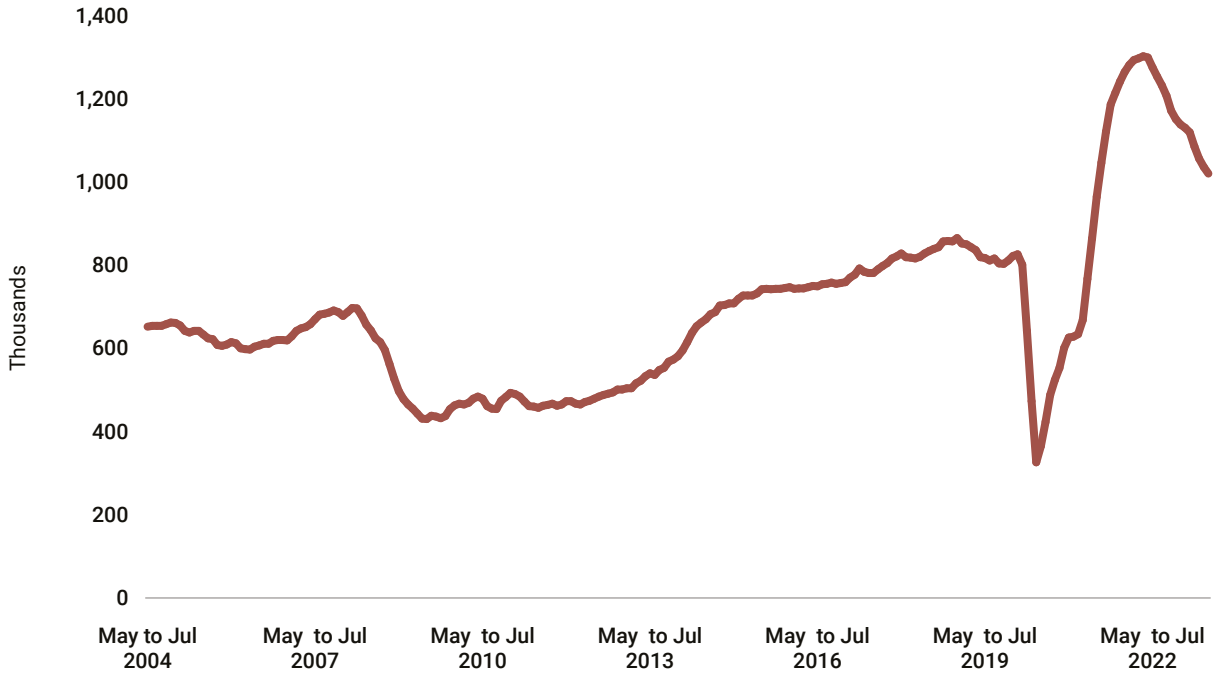
CHAPTER 2

International Context and UK Competitiveness

The previous section has set the critical economic and strategic position of industry in the UK and the barriers it faces in decarbonising. UK industry does not face this set of challenges and choices in a vacuum - the dial is shifting across the world towards bold policy and investment to support the greening of industry and industrial products, with the aim of securing the benefits of green growth. These developments are summarised in the next section and underline the imperative for the UK to grapple with the challenge it faces to decarbonise heavy industry without deindustrialisation.

This competition is further compounded by some macro challenges faced in the UK. The Chancellor set out in the Spring budget that one of the biggest blockers on growth is the UK's exceptionally tight labour market. The UK has high vacancy rates compared to the past (see chart below)[49] and the lowest workforce participation rate in the G7.[50]

Figure 8: Number of vacancies in the UK, seasonally adjusted, April to June 2004 to April to June 2023



Source: ONS data

Given the labour and skills shortages faced by many of the sectors we have outlined, ensuring that vacancies continue to fall and skills provision is better matched to gaps and future employment will be critical to ensuring UK industry can secure the benefits of the global green growth opportunity.

EU policy on industrial decarbonisation

The European Union (EU), alongside the UK, has been a leader in developing and implementing policy on industrial decarbonisation. In particular the EU Emissions Trading Scheme (ETS) is one of the first such schemes and the biggest of its kind, limiting emissions from around 10,000 installations in energy and manufacturing across the EU, covering 40% of the block's emissions.[51] By putting a price on carbon, the ETS plays a role in incentivising the investment in reducing industrial emissions which may not otherwise be recoverable commercially, such as in CCUS, or fuel switching to electricity or hydrogen.

However, pricing carbon domestically without a corresponding price on imported industrial goods creates the risk that emitting activities are offshored. This means that while emissions in the EU at the sites covered by the ETS have fallen significantly, there is a risk that this could be offset by the emissions embedded in cheap high carbon imports, otherwise known as carbon leakage. As well as making emissions savings potentially illusory, carbon leakage also disadvantages strategically and economically important domestic industries and manufacturing to their competitors in other countries without any carbon pricing system. To counter the increased risk of carbon leakage, the EU has also launched a Carbon Border Adjustment Mechanism, which means that certain goods will face an ETS equivalent carbon charge on their import into the EU.

It is right that the UK Government has consulted on the implementation of its own carbon leakage measures, including a CBAM and, as we will go on to discuss, the Government should aim for linkage of its own CBAM with the EU, in order to deliver simplification and reduce compliance costs for UK firms.

The Green Deal Industrial Plan (GDIP) is another key component of the EU's strategy to capture more of the global green industry market share. GDIP builds on the Green Deal, with four pillars of action to support the green transition across the EU:[52]

- **Regulation** - ensuring there is a fast track and simplified approach for key strategic projects and technologies to support the transition.
- **Funding** - greater access to existing EU funds as well as a future 'European Sovereignty Fund' to support clean technology innovation and manufacturing.
- **Skills** - a 'skills first' approach to net zero, looking at labour market access for those from third countries with key skills required, and a roll out of 'net zero industry academies'.
- **Supply chain** - ensuing global cooperation based on 'fair competition' using the EU's Free Trade Agreements to support green transition, as well as exploring a 'critical raw materials club to achieve security of supply from resource rich countries to consumers.

As is discussed in chapter [5], energy prices in European countries when compared to the UK are also a big underlying driver of the bloc's greater competitiveness. As a well as holistic strategy to support decarbonisation, addressing these costs will be critical for seizing the opportunity of a competitive low carbon industry for the UK.

USA IRA and industrial policy

The Inflation Reduction Act (IRA), signed into law in August 2022, sets out a range of investment and spending commitments to support the American economy, improve healthcare, and reduce carbon emissions among other objectives.[53] the IRA sets out nearly $400 billion in federal funding for clean energy, although the final total spent could be over $1 trillion according to some analysis.[54]

Most of this funding will focus on clean electricity production and transmission, and low carbon transport. It provides generous tax credits for the purchase of clean technologies such as EVs and low carbon heating, explicitly linked to the use of domestically sourced components such as batteries and minerals.[55] In stark contrast to similar schemes in the UK, these tax credits are uncapped and available to any qualifying household for the next decade. While this could result in significant costs to the US Treasury, it provides a clear long-term signal to American businesses to invest to develop the supply chain needed for the mass future demand for low carbon goods.[56] Corporations will also benefit from an estimated $216 billion worth of tax credits to help crowd in private investment in clean energy, transport, and manufacturing.[57]

The IRA is the latest step in American industrial policy, complementing the CHIPS ACT and the Bipartisan Infrastructure Law (BIL), to build domestic US production capacity in future industries. The IRA provisions on some key future green technologies, such as CCUS, build on the significant investment already promised in the BIL.[58]

Many have highlighted the IRA as a game changer for American industry, given its potential to support American

producers to capture an even more substantial share of the global green economy at the expense of countries such as the UK. It compounds existing advantages to US energy-intensive industries in the form of cheap electricity costs relative to the UK. This creates an even greater impetus for the UK to pursue reforms to strengthen and decarbonise its industry and manufacturing base.

Key materials: international approaches to decarbonisation

In addition to the major investment programmes into decarbonisation in the US and the EU, there is investment and innovation towards decarbonising industry happening across the world, providing both best practice and competition to decarbonising UK industry.

China's 14th Five Year Plan

In December 2021, the Chinese Government approved its 14th Five-Year plan (FYP), which sets an 18% reduction target for CO2 intensity and a 13.5% reduction target for energy intensity for the 2021-25 time period. The plan also refers to China's longer-term climate goals for the first time, outlining the aim to reach carbon neutrality by 2060, and introduces the concept of a CO2 emissions cap, although it does not go as far as to set one. Energy is at the heart of the plan's climate ambitions, with an entire section dedicated to establishing a modern energy system. Some analysts suggest the scale of investment required to achieve these goals would raise China's GDP by as much as 5% over this decade. One estimate says that investment into the power sector alone will grow by $4tn by 2060.[59]

The industrial sector is targeting electrification and efficiency improvements to meet demand and reduce its reliance on fossil fuels. Steel, cement and aluminium are the main drivers of emissions, and all are aligned with the economy-wide target for carbon peaking before 2030. These key emitting sectors will likely be the first targeted in the expansion of the country's ETS, planned to be brought in over the next two to three years. Adding this carbon price is likely to reduce some of the cost advantages that China currently holds in many industrial sectors.

Since the 10th FYP, China has invested more than 3 billion yuan into CCUS research and development. As with solar panels and wind capacity (36% and 39% of the global share, respectively), the huge demand that will be generated for decarbonising technologies as China transitions is expected to bring down its costs through economies of scale, as well as creating a sustainable market for them. Much of the technology and equipment necessary for decarbonisation is made in China - the increasing demand for and investment in these technologies will maintain its current market share and possibly grow it. The national hydrogen strategy and ambitious production target of 100m tonnes of renewable-based hydrogen by 2060 will grow the global market and could ultimately bring prices down for everyone to access this technology more easily. [60] China is already the world's largest producer of hydrogen, and the strategy confirms the technology's key role in China's future energy system and mitigation efforts.[61]

Low emission steel trials

There have been increasing examples across steel-producing countries of trials to confirm whether low carbon steel production can replace current methods.

Recently, ArcelorMittal, the world's leading steel and mining company, agreed to trial the use of high strength steel produced with low carbon emissions in structural car parts with Snop, a major tier-one European automotive supplier. The steel is manufactured with recycled and renewably produced substrate and typically has a CO2 footprint almost 70% lower than conventionally produced steel. High strength structural car parts have already been manufactured, with the first tests of the parts underway.[62] TThis follows a similar trial with automotive supplier Gestamp of steel produced with low carbon emissions for use in car parts for use in the production of vehicles in Spain, and then throughout Europe.[63]

In Canada, the opportunity has been identified to leverage Canadian auto manufacturers, especially those set to produce electric vehicles, to serve as an early, private sector market for Canadian "clean steel". The automotive sector requires high-spec steel, and the supply chain tends to be relatively short, giving more direct access for trials to take place. As steel is only 2-3% of the cost of building a car, and the auto sector is increasingly striving to reduce emissions themselves,

Canada and other countries are looking to use the sector as an early test for much of their low carbon steel. Given that the cost of producing clean steel will nonetheless be high and result in high prices, there is a call for the Government to support the market trials with financial contributions, possibly through a Contract for Difference (CfD), an instrument used to provide security in case of volatile or unsure price evolution, guaranteeing an agreed contract price and thereby funding any price gap between market prices and the actual costs for the producer.[64]

In 2021, SSAB announced that it had produced and delivered the world's first fossil-free steel to a customer. The steel was reduced by 100% fossil fuel-free hydrogen, instead of coal and coke, with good results, and delivered to Volvo Group after having been developed in collaboration with partners in the automotive industry. Its aim is to convert its factories in Sweden to deliver fossil-free steel to the market on an industrial scale by 2026. It has embarked upon a collaboration aiming to create the world's first fossil-free vehicles, with SSAB providing green steel for future production.[65]

Low-carbon cement in France

Earlier this year, Holcim trialled Europe's first calcined clay cement operation in France to deliver a low carbon cement with a 50% lower CO2 footprint compared to standard cement. This advanced production line will produce up to 500,000 tons of low carbon cement a year. Operations are powered with 100% biomass-based alternative fuels and waste heat recovery systems, making the manufacturing of calcined clay nearly carbon-free and highly efficient. In order to achieve this, Holcim received support from the French Government as part of the "France Relance" scheme investing in large-scale decarbonisation and energy efficiency initiatives in France.[66]

UK comparative advantage in heavy industry

As well as providing a regional job base and much-needed economic value outside of London, some of the heavy industry sectors we identified also hold significant comparative advantages in trade, boosting UK GDP through exports. This further underlines the potential for UK industry to seize the business benefits of the net zero transition in the global economy, given the right wider policy support.

We considered the importance of heavy industry to UK trade both now and in the future, looking at the relative proportion of exports from that sector in the UK vs globally to obtain the Revealed Comparative Advantage and leveraging the Green Growth Index to understand how comparative advantages are likely to shift in the future. See the annex for the methodology.

Comparative advantage today

The sectors we have identified as heavy industry make up 21.2% of all UK goods exports, only just behind the 22.6% they make up of global goods exports, showing that the UK still maintains a comparably healthy industrial base compared to the global picture. From this industrial base, these sectors produced an average of about £79 billion of export value per year in the UK between 2018 and 2022. Sectors are defined as having a comparative advantage if they export relatively more as a percent of total UK exports than the global sector does as a percentage of total global exports. Any Revealed Comparative Advantage figure **above 1.00** indicates a sector that the UK is relatively better at exporting than the rest of the world, and the higher the number, the stronger the revealed comparative advantage. Naturally, this is not a fixed value and is merely the current comparative advantage based on the last five year's trade numbers. It is likely to change over time, especially depending on the policy context – this mechanism is already being evidenced in the US, with lower production costs increasing export demand for goods supported by the IRA. Our Future Green Growth Index gives some indication of likely movements in trade advantages – and all of our sectors have the opportunity for improvement according to this metric (above 50.0 represents opportunity, below represents challenge).

Table 1: Heavy industry comparative advantage

Sector	Index of Revealed Comparative Advantage	Future Green Growth index	% of UK exports
Manufacture of beverages	**3.44**	**61.20**	**2.10%**
Manufacture of prepared animal feeds	**1.40**	**50.32**	**0.25%**
Manufacture of basic precious and other non-ferrous metals and Casting of metals	**1.23**	**50.53**	**5.41%**
Manufacture of dairy products	**1.02**	**50.32**	**0.52%**
Manufacture of grain mill products, starches and starch products	**1.00**	**50.32**	**0.65%**
Manufacture of basic chemicals, fertilisers and nitrogen compounds, plastics and Manufacture of pesticides and other agrochemical products and Manufacture of man-made fibres	**0.99**	**52.27**	**8.55%**
Paper and paper products	0.67	51.57	0.82%
Manufacture of glass, refractory, clay, other porcelain and ceramic products, Stone, & abrasive products	0.64	50.22	0.66%
Manufacture of basic Iron & Steel	0.53	50.53	1.24%
Rubber products	0.51	50.37	0.46%
Other mining and quarrying products	0.36	52.17	0.53%
Manufacture of articles of concrete, cement and plaster (please note subset of 663 code so already calculated in manufacture of glass etc. do not include if calculating totals)	0.35	50.22	0.01%
Manufacture of cement, lime and plaster	0.21	50.22	0.03%
Wood and of products of wood and cork, except furniture; articles of straw and plaiting materials	0.20	53.49	0.14%

Source: WPI Economics analysis

This analysis provided some very interesting results, revealing a comparative advantage in six out of the 14 sectors considered, highlighted in bold in the table above. There is significant variety between these sectors - they represent very different parts of the economy and very different skill bases, from food and beverage production through to the manufacture of precious and non-ferrous metals. They also vary significantly in terms of size and importance to their local economies, ranging from only 0.25% of total UK exports to 8.55%.

The biggest revealed comparative advantage out of these sectors is in the manufacture of beverages, representing 2.10% of UK exports as compared to 0.61% of world exports. The sector created an average export value of nearly £8 billion per year between 2018 and 2022, and with a big domestic market is also significant in terms of GVA and jobs contributions to the domestic economy.

The agricultural processing sectors with a comparative advantage (dairy, prepared animal feeds and grain mill products and starches) are all fairly small in terms of export value (under 0.7% of total UK exports) but together represent a significant amount of GVA and jobs for regional economies.

With a large share of total UK exports (5.4%), the non-ferrous metals and metals casting sector is also a strong comparative advantage for the UK with future opportunities for growth. This compares to only 4.4% of total global exports. The sector covers non-ferrous metals but also manufactured steel products outside of basic steel. Together, these two elements comprised a huge £20.2 billion average export value for the UK between 2018 and 2022.

Whilst the chemicals sector technically is under 1.00 and therefore not a comparative advantage, it is a hugely important sector to the UK, both strategically and as a supply chain facilitator for other industries, so we have considered the 0.99 score to be close enough to be considered an advantage. Representing a vast 8.55% of total UK exports, the sector averaged just over £40 billion a year in export value between 2018 and 2022. The domestic market is also significant, with 0.6% of the UK's total GVA and more than 100,000 jobs across the sector and supply chain.

Comparative advantage in the future

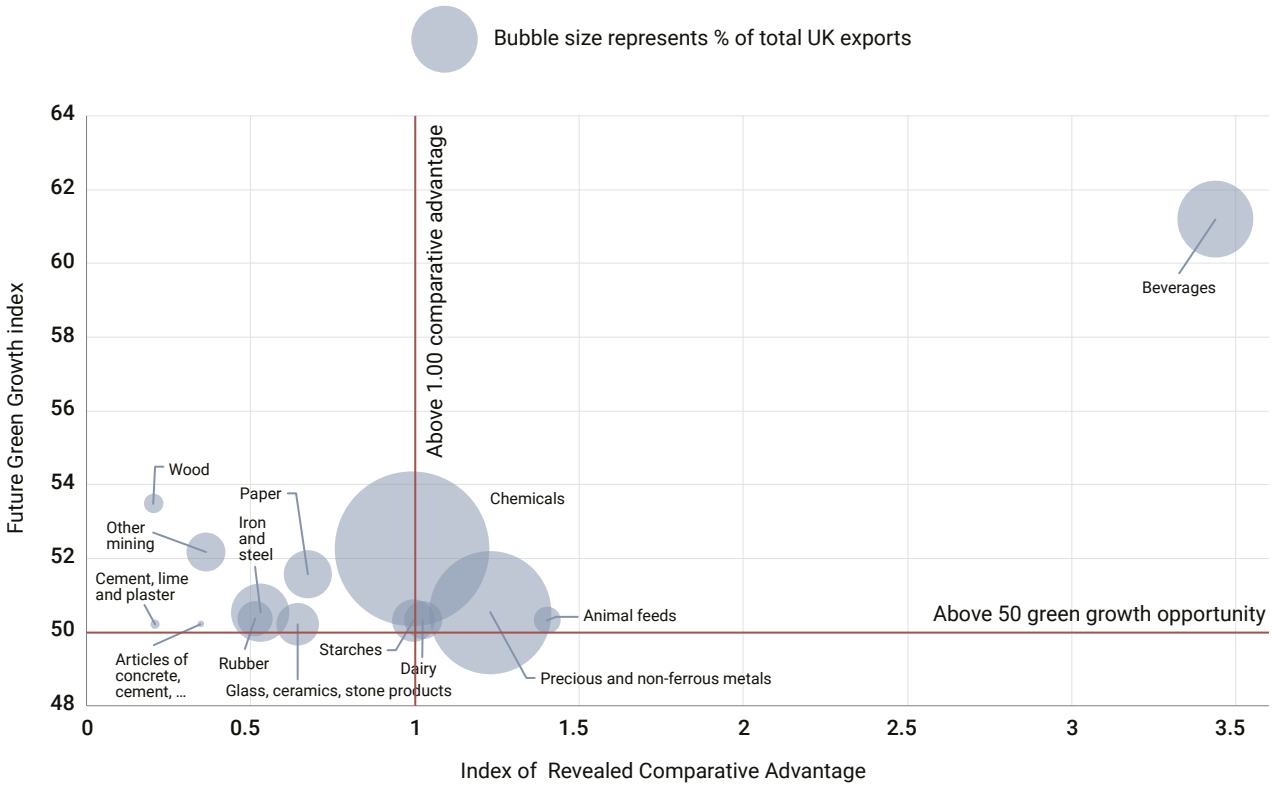
The Future Growth Index is a weighted index developed by taking the regional results from the Green Growth Index[67] and applying them to each sector, weighted by the regional split of GVA. The Green Growth Index assesses the degree to which each UK nation and region may be impacted by the challenges of the transition to a green economy and how well placed they may be to capitalise on green growth opportunities. Our Future Growth Index therefore shows how well placed each of the considered sectors are to capitalise on the opportunities and face the challenges of the green transition, based on the opportunity/threat balance within their regional contexts.

The nature and scale of opportunities and challenges during the green transition will vary significantly across the UK. According to the Oxford Economics Green Growth Index, disruption to activities will be greater in areas where there are concentrations of high emitting industries, and more scaling back of activity or drastic change will be required. However, these same concentrations will allow for economies of scale and easier clustering of decarbonisation solutions, potentially at the expense of dispersed sites, where there is concern that infrastructure support will not be available. Areas which have an emerging base of green economy activity will be better placed to quickly capitalise on new opportunities, with the existing skills base on hand to rapidly adapt to new innovation requirements. Broader competitiveness factors in general, particularly those related to skills and innovation, will also make for varying experiences of the green transition across the nations and regions in the UK.

Given the geographically dispersed nature of heavy industry activity in the UK, these sectors will face different combinations of opportunities and challenges depending on the geographical context of their production sites. This balance between the opportunities and challenges is set to determine how existing comparative advantage will change into the future, **with a Future Growth index rating above 50 representing relatively more opportunity, and below 50 relatively more challenges**.

The table below considers the current and future positions of the sectors, measured by Revealed Comparative Advantage (current) along the x axis, their Future Growth index value (future) along the y axis and the size of the bubble representing the size of the prize (in terms of % of total UK exports the sector represents).

Figure 9: Heavy Industry Current and Future Trade Advantages



Source WPI Economics analysis

All our sectors are distributed across regions with relatively more opportunity than threat, though some face significantly better conditions for the green transition than others. Not only does the UK hold some existing comparative advantages in trading heavy industry goods, but it could boost that advantage in the future, even without further investment, as the variety of opportunities available within the green economy become clear across the country. Whilst beverages is a clear sector to watch, with a strong present comparative advantage likely to be built upon in the future, all the heavy industry sectors can leverage their relative balance of opportunity over threat to develop a future trade advantage. Any investment or policy support that boosts the opportunities or reduces the challenges across sectors/regions will also contribute to developing and solidifying trade advantages, baking in both the economic and socio-political advantages of being a global market leader in decarbonised industry.

Furthermore, it is critical to underline that any existing comparative disadvantage is not destiny. As we have set out, we are seeing across the world how policy, investment and regulation can change the game in terms of the attractiveness of traditional industry sectors to investors and their export potential. This further underlines the importance of an industrial strategy in the UK which packages a series of interventions around energy costs, carbon pricing and leakage, long-term investment and demand-side measures to collectively give all UK industry sectors the best chance of thriving in the global green transition.

A significant and growing comparative advantage in beverages manufacture

The beverages sector, which holds a significant comparative advantage today, is also well placed to leverage this existing advantage into the future. Over 40% of the sector's GVA is produced in Scotland, where the Green Growth Index suggests green growth opportunities are particularly strong, given an existing base of green economy activity (particularly in the energy sector) as well as access to a workforce with relevant skills for the green transition. Despite a significant chunk of activity (16%) in London, where the service-oriented economy means less exposure to the challenges of green transition, but also less opportunities to join up with the green economy, the strong presence in Scotland makes beverages the sector with strongest balance between opportunity and threat in the future green economy. We would therefore expect the beverages sector to bolster their existing comparative advantage further, leveraging the innovative and competitive green economy context of their regional distribution.

Slow improvement in trade performance expected across all heavy industry sectors

The remaining sectors are clustered around the 50-55 index value, indicating only a narrow tendency towards growth in the future over challenges. As such we expect existing levels of comparative advantage to only marginally improve into the future, and for these sectors to only see slow improvement in their trading performance without further support for these sectors.

Agricultural sectors face a mix of opportunity and challenges due to their geographic distribution

Of the sectors with a current revealed comparative advantage, the agricultural processing sectors (animal feed, dairy, grains and starches) are much less concentrated in a single region than the beverages sector, with around 15% of GVA in the North West, Yorkshire and the Humber, and the East Midlands. These areas, particularly Yorkshire, are likely to face more challenges than other English regions, due to a strong dependence on carbon intensive industry, high emissions, and hosting a lot of fossil fuelled power generating capacity, all factors which will need to be overcome for a successful transition. The Midlands has the greatest dependency on carbon intensive industry, with more than 11% of jobs estimated to require upskilling to meet the needs of net zero. However, whilst Yorkshire's opportunity evaluation is relatively low, and the Midlands has a lower concentration of renewable energy to access than other parts of the UK, the North benefits from strong opportunities in green industry, particularly in the energy sector.

Non-ferrous metals and metals manufacture to be boosted by growing green economy in the North

More than half of activity in the precious and non-ferrous metals manufacturing sector is distributed between the East Midlands, Yorkshire and the Humber and the North West. This means the sector faces a mix of challenges in terms of the scale of transition required, and potential barriers to accessing renewable energy, but also the opportunities presented by the growing green economy of the North of England.

A skilled workforce and R&D activity will strengthen existing advantages in the chemicals sector

The chemicals sector performs slightly more strongly due to a heavy presence in the North (24.5% of activity) where opportunities are anticipated to be strong in the green economy, counteracting the challenges presented in Yorkshire and the Humber (17% of GVA). A significant pocket of activity in the South East (12%), where industry is well placed to capitalise on a strong base of R&D activity and a skilled workforce, further boosts the opportunity balance for the chemicals sector.

CHAPTER 3 Benefits of heavy industry today

This section covers the social and economic benefits of decarbonisation of industry, already touched on in the report previously. The focus on this is the new analysis for this report, which is the economic benefits of both (a), traditional heavy industry, and (b), new and emerging low carbon industries.

Economic benefits of decarbonising traditional heavy industry sectors

The heavy industrial sectors we have identified play a vital role in the British economy. Not only do they represent over £46 billion of direct gross value added (GVA) and nearly 430,000 jobs, but they also contribute vital economic activity in more deprived areas of the country and facilitate a much larger pool of economic impact up and down their supply chain.

Producing value up and down stream

The heavy industry sectors we have considered have extensive, often tailored and targeted supply chains feeding into them. Meanwhile, they also support and supply extensive networks downstream in their production chain. Essential sectors, such as steel or glass, create a wide net of demand for inputs and specialist skills and provide a vital part of the supply chain for other key strategic sectors such as construction, automotive, or green tech. As well as collecting information on the direct value added and jobs the heavy industry sectors create, we have modelled the indirect and induced impact for both (see Annex 1 for methodology).

When considering the wider economic impacts, a staggering 1.4 million jobs are supported by heavy industry sectors, and nearly £152 billion of direct, indirect and induced added value.

Table 2: Current GVA contribution of heavy industries

		Gross value added in 2022 (£m)			
Industry name	**GVA in 2022 (£ million)**	**Direct**	**Indirect**	**Induced**	**Total**
Other mining and quarrying products	2,812	2,812	3,301	2,955	**9,068**
Manufacture of dairy products	2,653	2,653	6,207	4,060	**12,920**
Manufacture of grain mill products, starches and starch products	1,207	1,207	2,855	2,089	**6,151**
Manufacture of prepared animal feeds	1,802	1,802	6,389	4,127	**12,318**
Alcoholic beverages & Tobacco products	4,938	4,938	6,179	4,825	**15,942**
Soft drinks	2,113	2,113	2,364	1,894	**6,372**
Wood and of products of wood and cork, except furniture; articles of straw and plaiting materials	5,120	5,120	3,695	4,744	**13,559**
Paper and paper products	4,589	4,589	4,321	5,136	**14,046**
Industrial gases, inorganics and fertilisers (all inorganic chemicals) - 20.11/13/15	1,721	1,721	2,464	2,043	**6,228**
Dyestuffs, agro-chemicals - 20.12/20	1,348	1,348	710	968	**3,026**
Manufacture of other chemical products	1,707	1,707	1,542	1,610	**4,859**
Rubber products	1,036	1,036	853	1,131	**3,020**
Manufacture of glass, refractory, clay, other porcelain and ceramic products, Stone, & abrasive products	3,249	3,249	2,983	3,534	**9,766**
Cement, lime, plaster and articles of concrete, cement and plaster	5,312	5,312	4,291	4,777	**14,381**
Manufacture of basic Iron & Steel	2,921	2,921	4,346	4,275	**11,542**
Manufacture of basic precious and other non-ferrous metals and Casting of metals	3,681	3,681	2,502	3,099	**9,282**
Total	**46,209**	**46,209**	**55,002**	**51,268**	**152,479**

Source: WPI Economics analysis

For every person directly employed in the heavy industry sectors we have considered, an average of an additional three are supported in the wider economy, driving employment and supporting household spending, often in areas which need the economic boost the most. Direct jobs include all the roles in the sector created to fulfil the demand for the product (for example, producing cement, managing the workers at a cement factory, transporting the cement around the plant). Indirect jobs are those that exist to produce the goods and services needed by the workers with direct jobs (for example the roles that produce the fuels required to produce cement). Finally, induced jobs include all those that are created by direct employees spending money in their community earned from their jobs (e.g., the wait staff at the lunch venue near the cement plant).

Table 3: Current Employment contribution of heavy industries

		Employment (Full-time equivalent) in 2021			
Industry name	Jobs (full-time equivalent) in 2021	Direct	Indirect	Induced	Total
Other mining and quarrying products	19,220	19,220	24,531	17,282	**61,034**
Manufacture of dairy products	20,868	20,868	83,760	39,564	**144,192**
Manufacture of grain mill products, starches and starch products	9,500	9,500	39,051	21,950	**70,501**
Manufacture of prepared animal feeds	15,939	15,939	67,151	33,298	**116,388**
Alcoholic beverages & Tobacco products	32,240	32,240	67,089	41,323	**140,651**
Soft drinks	12,956	12,956	31,247	18,550	**62,753**
Wood and of products of wood and cork, except furniture; articles of straw and plaiting materials	65,532	65,532	32,379	31,152	**129,063**
Paper and paper products	50,507	50,507	53,570	48,334	**152,411**
Industrial gases, inorganics and fertilisers (all inorganic chemicals) - 20.11/13/15	9,475	9,475	10,007	7,182	**26,664**
Dyestuffs, agro-chemicals - 20.12/20	5,688	5,688	5,799	6,881	**18,368**
Manufacture of other chemical products	20,135	20,135	21,117	17,742	**58,994**
Rubber products	17,059	17,059	9,083	9,674	**35,816**
Manufacture of glass, refractory, clay, other porcelain and ceramic products, Stone, & abrasive products	49,887	49,887	26,718	26,168	**102,773**
Cement, lime, plaster and articles of concrete, cement and plaster	29,368	29,368	42,140	36,227	**107,736**
Manufacture of basic Iron & Steel	38,646	38,646	51,959	38,729	**129,334**
Manufacture of basic precious and other non-ferrous metals and Casting of metals	30,750	30,750	19,880	19,028	**69,658**
Total	**427,767**	**427,767**	**585,483**	**413,084**	**1,426,334**

Source: WPI Economics analysis

In terms of both value added to the economy and jobs provided, the heavy industry sectors make an outsized impact on the economy, supporting a much wider set of markets than just each sector alone. This economic contribution cannot be understated, and without investment to invest in new technologies to reduce emissions and seize green market opportunities, the economic benefit of these industries will slowly be eroded as they struggle to decarbonise and potentially even close up shop and move elsewhere.

Levelling up the regional economies

The heavy industries are an important part of the UK economy, but they are an absolutely essential part of specific regional and national economies. Many areas rely strongly on industry to support jobs and economic activity - 28% of total heavy industry GVA is in the North alone, bringing nearly £42 billion and over 400,000 jobs to the local economies. A further £29 billion and 290,000 jobs in the Midlands shows how important avoiding deindustrialisation is to the levelling up agenda within England's regions.

Scotland's (£18 billion and 138,000 jobs) and Wales' (nearly £11 billion and 121,000 jobs) economies also benefit greatly from heavy industry. The beverages sector, with the strongest comparative advantage in trade, is a significant part of the heavy industry activity in Scotland, benefiting the nation not just in the form of jobs and value added, but international prestige and brand recognition as well, and the consequent benefits to other areas of domestic trade. Scottish whiskey is a world-renowned British good, and its popularity can and has been leveraged to strengthen branding on other export goods.

The importance of maintaining industrial activity to regional economies is demonstrated below - we have mapped the total direct, indirect, and induced GVA and jobs against the regions, showing the essential contributions heavy industry makes, distributed across the UK and mainly in areas with fewer other options for economic activity.

Figure 10: Map of total heavy industry GVA distribution

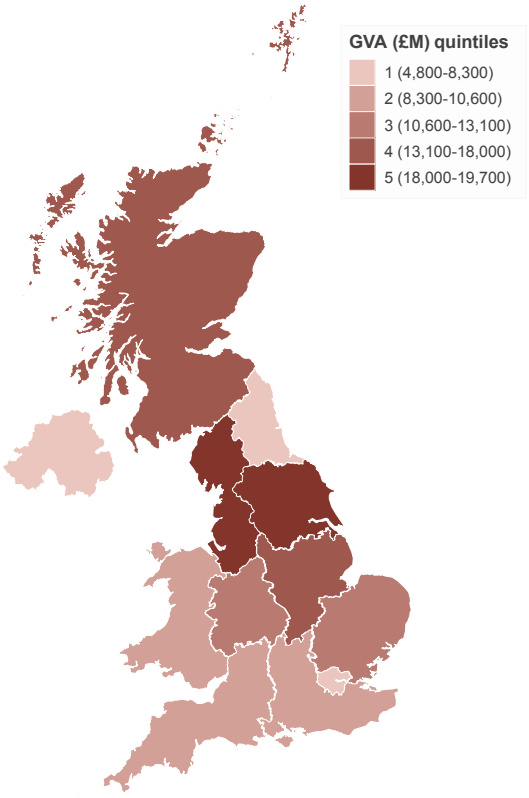
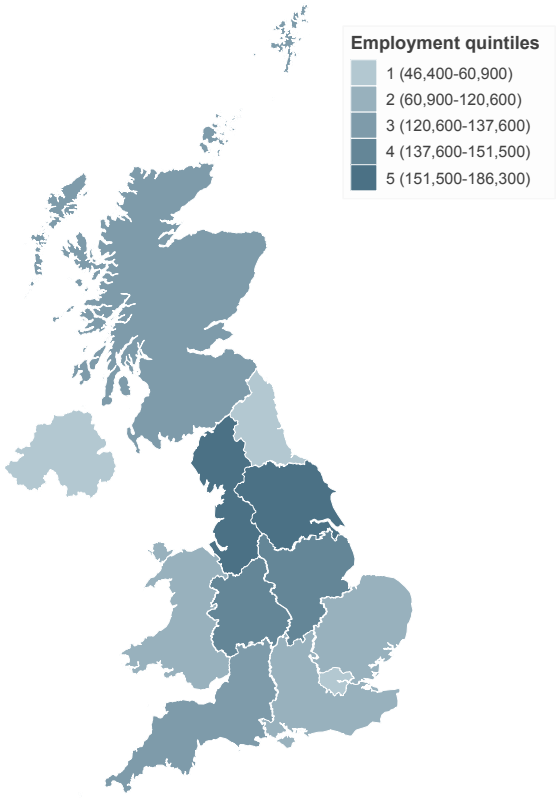


Figure 11: Total heavy industry employment distribution



Economic benefits of emerging low carbon sectors

As we have set out, decarbonising traditional industrial sectors to support them to thrive in the UK will deliver a whole range of social, strategic, and economic benefits. Decarbonisation of these sectors will also mean scaling currently nascent technologies such as CCUS and hydrogen, which in turn will become new sectors of their own.

Using the Data City approach, we have mapped the companies that make up these emerging sectors and used these to estimate their total turnover and number of employees.[68] The Data City approach helps us to understand these sectors without relying on SIC Codes, which are not well suited to emerging sectors.

The numbers for the CCUS and Hydrogen sectors in the UK can be found below:

Table 4: CCUS list

Number of companies	Employees	Combined Turnover	Expected growth per year
71	1,166	£1.2 billion	9.60%

Source: Data City and WPI Economics analysis

Table 5: Hydrogen list

Number of companies	Employees	Combined Turnover	Expected growth per year
285	2,642	£510 million	28%

Source: Data City and WPI Economics analysis

Table 6: Combined industrial decarbonisation list

Number of companies	Employees	Combined Turnover	Expected growth per year
356	3,745	£1.7 billion	20%

Source: Data City and WPI Economics analysis

These are significant but nascent sectors within the UK. The Data City estimates substantial growth potential for these sectors, with the potential for these to be large multi-billion-pound contributors to the UK economy in future.

As part of this research, we also attempted to map the emerging electrification sector, including technologies such as Electric Arc Furnaces (EAF) for producing steel. Ultimately, this activity was hard to find using The Data City process because it was difficult to isolate these activities from broader activity within larger industrial companies. Furthermore, it is important to note that there will be CCUS and Hydrogen activity that occurs within much bigger traditional industry companies that are not captured by the lists we have created. The Data City approach gives us only one part of the picture – but a critical one that is not captured by SIC codes.

With emerging sectors, it is useful to establish where any clusters are beginning to emerge in the country. In terms of current employment, Yorkshire and the Humber and Scotland are the major regions of the UK for these sectors, using a location quotient[69] metric.

Table 7: Industrial decarbonisation sector employees by region

Region	Location quotient
Yorkshire and The Humber	5.1
Scotland	3.4
London	1
South East	0.9
North East	0.6
East Midlands	0.5
South West	0.3
West Midlands	0.3
Northern Ireland	0.3
North West	0.1
East of England	0.1
Wales	0

Source: Data City and WPI Economics analysis

Social benefits of decarbonisation

As well as providing substantial economic benefits to national and regional economies and the wider supply chain, industry has an important footprint in the communities it operates in. The following case studies help to articulate how the sectors we identify can produce dividends for the communities they operate in as we decarbonise.

Case Study 1: Port Talbot

The port and steelworks at Port Talbot is one of the UK's most significant and longstanding industrial sites. It is the site of one of the biggest steelworks in the world, and the port itself handles 6.6 million tonnes of cargo every year. It has been through several periods of change since the industrial revolution and currently faces choices around how to adapt and compete in a low carbon future.

Associated British Ports (ABP) has set out four missions to secure Port Talbot's green future:

- Decarbonising energy – including through Floating Offshore Wind (FLOW) in the harbour.
- Decarbonising manufacturing – using CCUS and/or hydrogen to decarbonise the Port Talbot industrial cluster.
- Decarbonising logistics – a new rail connection to reduce emissions and transport low carbon goods and fuels in combination with a long-term plan to decarbonise shipping.
- Creating growth environments – crucially, ensuring that this programme of investment can be translated into growth and opportunities locally and also support the local environment. This includes ensuring access to skilled jobs across Wales, as well as identifying opportunities to improve public amenity through greater community ownership.

Case Study 2: City of Bradford

Bradford in West Yorkshire is one of the earliest industrial cities in the UK. Its economy is worth £11.6 billion and is the tenth largest in England. The industrial base of the city provides 12% of local employment, higher than the national 8% in manufacturing. It hosts a range of industries, including chemicals, advanced engineering, automotive, food and drink, aerospace, and textiles. Bradford Pathways, an employer-led growth model, is a key economic growth strategy where people will be enabled to meet employers' skills requirements through education, apprenticeships and community coaching. This will be extremely beneficial to the high level of mid-skilled residents of Bradford. However, Bradford has poor regional connectivity and faces high levels of deprivation, ranked 5th most income-deprived local authority in England in 2019. This will worsen in the absence of anchor industries that support regional development. Should these industries move overseas in the process of deindustrialisation, or if net zero efforts fail to create a market and a viable commercial model for low carbon products, cities like Bradford will face extreme economic downturn, severely impacting the quality of life of its residents and failing to meet the goals of various national growth plans.

CHAPTER 4

Benefits of decarbonisation tomorrow

Decarbonisation vs deindustrialisation of heavy industry

Alongside the many current social, strategic and economic benefits of decarbonising heavy industry today, we also need to consider the importance of avoiding deindustrialisation and maintaining those benefits into the future as emissions are drastically cut and net zero approaches. As it stands, without significant investment into innovation and infrastructure to support dramatic changes in how these goods are produced, there is a very real risk that many of these sectors will not be competitive on the global scale and help the UK realise the benefits of the global green transition. Furthermore, they may even fail to be sustainable as domestic industries due to the increased costs of low carbon production.

In order to understand the depths of damage that could be done to the UK economy should deindustrialisation by default be allowed to occur, we have modelled the future of GVA and jobs in these heavy industries according to four scenarios. See the methodology in Annex 1 for further detail. These are:

1. **Deindustrialisation by default** - we model GVA to decline in line with the reductions in emissions required by the CCC plans for the relevant industries in order to reach net zero by 2050. This is a vision of what will happen should the status quo be allowed to continue unchanged

2. **Investment across heavy industry** - this is our most optimistic scenario, where we assume that a combination of increased investment in existing technology and technological breakthroughs maintain all heavy industry sectors' shares of national GVA at current levels through to 2050. This is based on the carbon intensity of these industries reducing significantly during this time period.

3. **Investment in strategic industries** - this scenario assumes that investment and innovation efforts are focused only on key strategic industries, determined as those with high domestic demand and importance in the supply chains of key sectors such as infrastructure, defence, energy, healthcare and transport. This maintains the shares of these sectors at their current proportion of national GVA, whilst the remaining sectors are modelled as per scenario 1.

4. **Investment in competitive industries** - here the investment and innovation efforts are concentrated on those industries determined to be competitive internationally (i.e., those with a comparative advantage according to our analysis). The shares of competitive sectors will remain constant as a proportion of national GVA, whilst the remaining sectors see deindustrialisation.

Table 8: scenario description

Scenario	Focus sectors receiving investment
1: Deindustrialisation by default	None
2: Investment across heavy industry	All heavy industry sectors
3: Investment in strategic industries	Chemicals, glass and ceramics, iron and steel, cement
4: Investment in competitive industries	Dairy, grain mill products and starches, prepared animal feeds, beverages (alcoholic and soft), chemicals, basic precious and non-ferrous metals

Table 9: GVA and employment scenarios

	2022	Scenarios for 2050			
		1	2	3	4
Total heavy industry GVA (£m 2022 prices)	152,479	11,632	235,344	83,284	127,698
% of total national GVA	6.43%	0.31%	6.22%	2.20%	3.37%
Total employment	1,426,334	81,000	1,634,111	531,417	853,813

Source WPI Economics analysis

Scenario 1: Deindustrialisation by default

In the extreme case of providing no further policy, regulatory or investment support for heavy industry's net zero transition and therefore allowing industry to deindustrialise as it struggles to meet carbon requirements, our model forecasts that the sector's share of national GVA would collapse, from 6.4% in 2022 (including direct, indirect and induced GVA) to merely 0.3% in 2050. In this scenario, heavy industry provides only £11 billion GVA in 2050 - when compared to the counterfactual of full investment in our optimistic scenario 2, this is equivalent to wiping out over £224 billion (in 2022 prices), or 5.9% of total GVA in 2050.

Scenario 2: Investment across heavy industry

Our most optimistic scenario envisages support across all of heavy industry through a combination of policy, regulatory and investment actions. With this support, heavy industry represents just over 6.2% of national GVA in 2050 at nearly £236 billion, a growth of nearly £83 billion from 2022's total value as industry takes advantage of the opportunities presented by green markets, and roughly maintaining current share of national GVA.

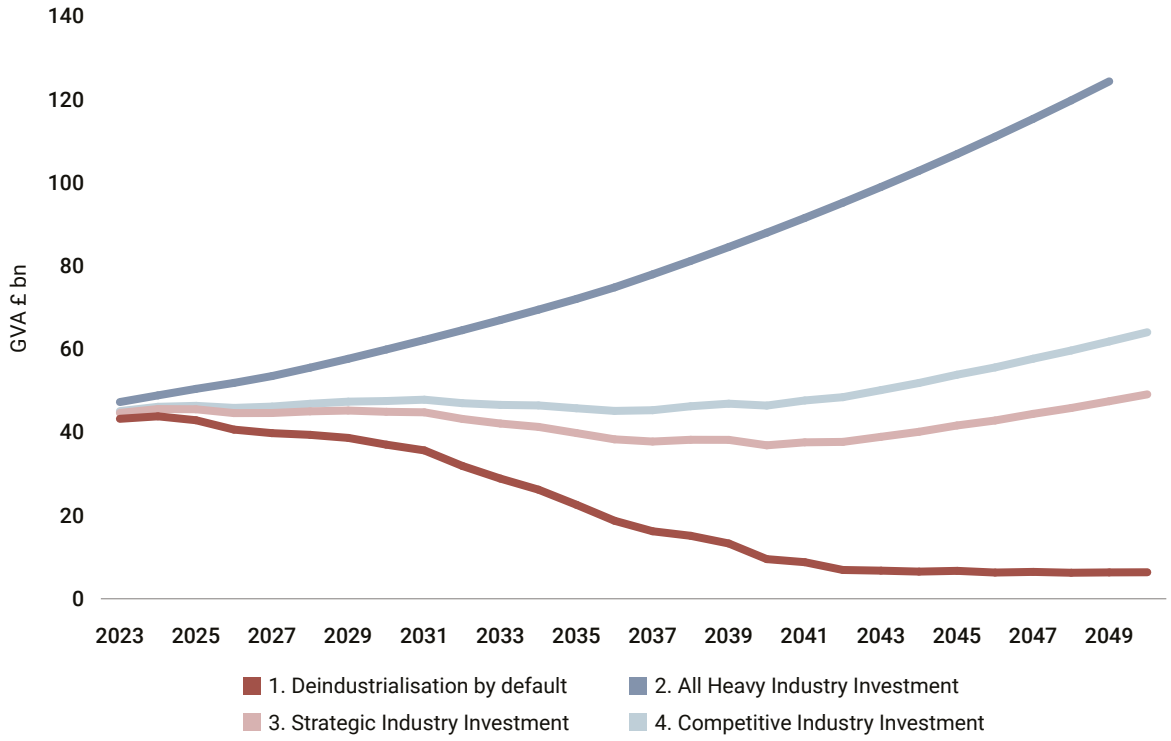
Scenario 3: Investment in strategic industries

Our scenarios 3 and 4 show that investment in a subset of heavy industry sectors identified as important for a variety of reasons still has significant economic benefit in terms of both GVA and employment compared to the counterfactual, although to a lesser extent than scenario 2 where there is no targeting of investment. Our model finds that investing in the green transition for strategic industries would avoid the loss of more than 450,000 jobs and £72 billion of GVA in scenario 3, as well as providing significant benefits in terms of domestic supply chain resilience for a much wider net of industries and sectors outside of the heavy industries we have identified. Given the importance of heavy industries to regional economic growth, it is also essential to support their continued contribution in these regions. When supporting the strategic industries, Yorkshire and the Humber, the West Midlands and the North West benefit the most in terms of both GVA and employment, with all the advantages for levelling up the regions this would entail.

Scenario 4: Investment in competitive industries

Providing support for those industries which have been identified as well placed to compete in green markets across the international sphere is the second most lucrative in terms of future GVA, though would not do as much to support domestic supply chain resilience as investing in key strategic industries. Ideally, a combination of both could both provide huge economic benefit and a strategic shoring up of national resilience to disruption. Our scenario 4 analysis suggests investing in these competitive industries would avoid the loss of over 770,000 jobs and over £116 billion of GVA in scenario when compared to the counterfactual of deindustrialisation by default. Investment in this scenario benefits London and Scotland the most in terms of GVA, and the Northwest, London and the South West in terms of employment.

Figure 12: GVA (at current prices, seasonally adjusted, £ bn) scenarios projection



Source: WPI Economics analysis

Decarbonising to protect the future economy and domestic supply chains

Apart from preserving the UK's industry position in the UK by mitigating risks of deindustrialisation, efforts to decarbonise the foundation sectors of the economy bring a lot of direct and indirect benefits such as:

1. **Positioning the UK as a world leader through sectoral growth:** The UK has a relatively advantageous position in many of the foundation industries in terms of the availability of raw materials and domestic markets. For instance, the country produces over 95%[70] of the concrete it needs , and is known for its high quality. With the right policy and investment support, there is opportunity for the UK to break into global markets for net zero cement worldwide.

2. **Achieving self-sufficiency in the industrial net zero journey:** As discussed in Chapter [1], the foundation industries are very important for the renewable energy sector. Steel is used to produce equipment used for wind turbines, electric vehicles, and rail networks, while glass and ceramics are necessary for wind and solar technology, and vehicle manufacturing. Chemicals are uniquely positioned in their net zero applications, being integral for low carbon processes as well as being used as low carbon fuels. Cement, glass and steel also have knock-on effects in the form of increasing energy efficiency in the construction sector through product efficiency and smart design. A robust foundational industry sector is highly beneficial for the UK's net zero trajectory.

3. **Pioneering the growth of emerging sectors:** The UK has been making concerted efforts in the sectors of advanced manufacturing, green technology, life sciences and digital technology. All these sectors rely on high-precision products for their advanced technological manufacturing processes. Glass, ceramics, and chemicals are integral for these emerging sectors and a robust domestic supply chain of this raw material is important for the UK to become a global leader in emerging sectors.

4. **Increasing the UK's exports potential:** Some sectors like chemicals contribute greatly to the UK's export with 63%[71] of domestically produced products being exported. The demand for decarbonised products will only increase worldwide. The UK has an opportunity to add value to its already robust chemical exports sector and become a key global supplier. The UK's steel sector, on the other hand, despite being a net importer, exports 43%[72] of its finished steel products. With the European Union and multiple other countries implementing Carbon Border Adjustment Mechanisms (CBAM[73]), some have identified a risk to the export potential of UK steel.

CHAPTER 5 Policy Recommendations

As we have set out, there are major benefits to the UK decarbonising industry and capturing more of the global market for green goods. In addition, there are substantial economic, social, and strategic risks attached to continued inaction. This section sets out some of the key interventions which as a minimum are needed to support low carbon industry and manufacturing to survive and thrive in the UK.

Industrial strategy

It is imperative that the **Government defines its objectives for industrial decarbonisation and then sets out a long-term strategy with the key interventions needed to deliver these**. This industrial strategy can then underpin individual interventions needed and set out a clear overarching framework for change around which businesses and investors can plan.

As a minimum this industrial strategy needs to include

- C**larity for the decarbonisation pathways for industry** – there needs to be a clear, joined up plan for how, where, and by whom different fuels will be used, with clear guidance around how decisions have been made about prioritising limited technology such as CCUS and green hydrogen. The Government should provide clarity sooner rather than later to help firms and investors plan. One key initial step should be around ruling out any significant role for green hydrogen in home heating, given that heat pumps are a greener and more efficient alternative.
- **A blueprint for the infrastructure needed for deep decarbonisation** – tthe Government needs to set out a long-term plan for how it will invest in and co-fund the infrastructure critical for a successful industrial transition. This includes grid infrastructure (which is critical for all low carbon technologies), hydrogen and CCUS. Business cannot deliver this on its own, and without government support for delivering this infrastructure, decarbonisation is simply not viable for many UK industry sectors.
- **A strategy for the flow of critical materials and minerals** – while much of the raw material needed for UK industry can be met by domestic supplies, there are a number of critical areas where key sectors are reliant on imports. This includes soda ash for glass making, aluminium, magnesium and silicone oxides required for ceramics, as well as cobalt and lithium for electric vehicle (EV) batteries. Policy to support better retention and recycling of waste and scrap products in the UK could ensure a more reliable supply of these critical materials.
- **Strengthened supply chain relationships and domestic capacity** – with a clear and renewed focus on those industries which are (a) strategically important and (b) a comparative advantage for the UK economy,, the Government should look at what is needed to ensure that these sectors have the domestic production capacity and the supply chain required. This includes identifying the roles that will be in high demand in the future and developing the required pipeline of skills.

Industrial strategy cannot guarantee the success of UK industry in a global market. However, it can create the conditions which allow our industrial firms to be more competitive. Some of the key individual interventions within a pro-industrial policy package can be found below.

Electricity prices

There was unanimous agreement from industry stakeholders spoken to for this project - across the full range of sectors - that electricity prices are the biggest threat to both the competitiveness of industry in the UK and the business case to invest in decarbonisation. A substantial supply of competitively priced electricity is needed for technologies such as Electric Arc Furnaces (EAFs), as well as CCUS and low carbon hydrogen. The fact that electricity prices are so much lower in other markets is the most significant challenge to any business case for investment in the UK in comparison to elsewhere. For example, in the UK, industrial customers paid £43/MWh, in comparison to £23/MWh for France, £24/MWh for Germany, and £28/MWh for the Netherlands.[74]

There are a number of drivers of these differences in prices. One which has been highlighted in work by University College London (UCL) and Aldersgate Group is the extent to which electricity prices are set in the UK by marginal fossil fuel (especially gas) prices in comparison to other European countries. A Green Power Pool, whereby industrial customers pay for power at a cost nearer the price of providing renewable electricity, has been floated as one potential solution to this issue.[75]

Table 10: Percentage of time for which electricity prices were set by different sources in 9 major European countries (2021)

Country	Fossil Fuel	Non-fossil	Imports
Germany (DE)	72%	11%	17%
Denmark (DK)	31%	12%	57%
Spain (ES)	65%	32%	4%
France (FR)	7%	93%	0%
Ireland (IE)a	72%	2%	26%
Italy (IT)	82%	14%	4%
Greece (GR)	91%	9%	0%
Portugal (PT)	40%	60%	0%
Great Britain (GB)	98%	2%	0%

Source (Zakeri et al, 2022), Table 2

Here, Contracts for Difference (CFD) are a vital tool for policymakers. Increasing the CFD strike price would help take into account the recent rise in input costs for developers, ensuring that investing in renewables in the UK continues to make good business sense. Furthermore, **voluntary CFDs could be employed to help companies avoid having to unwind big hedges and to provide confidence in prices in the short term**.[76] Furthermore, over time, the **Government needs to rebalance policy costs from levies on energy from electricity to gas** as a means of incentivising greater investment in electrification, while ensuring support for industries such as ceramics which cannot currently electrify.[77]

Government should also explore options to enhance the Power Purchase Agreement (PPA) market, including mitigating the risk of off-taker payment default. This can be achieved by, for example, developing standardised, tradeable PPA contracts or offering state guarantees. Reducing electricity prices for industrial customers is a vital prerequisite to any successful industrial strategy, which decarbonises industries without deindustrialisation.

UK Emissions Trading Scheme and Carbon Border Adjustment Mechanism

As discussed, future deep decarbonisation measures (electricity, hydrogen, CCUS) will likely be a cost to industry overall, which cannot be recovered commercially. This stands in contrast to previous measures around energy and resource efficiency, which reduce costs to producers as well as emissions.

The UK's own ETS is the main measure in place to ensure there is an incentive for investment in industrial decarbonisation. This is the UK's replacement of the EU's ETS described in Chapter [2]. We recommend two reforms to ensure that the UK ETS fully delivers on its objectives.

Firstly, the EU ETS has a function called the Market Stability Reserve, which withdraws surplus allowances under the ETS from the carbon market that would otherwise run the risk of lowering the carbon price, disincentivising investment in industrial decarbonisation.[78] No UK equivalent has been introduced, despite a recent consultation on changes to the ETS. This risks surplus allowances building up in the carbon market over time, which lower the overall carbon price. As a result, **it is critical that UK policymakers rectify this by introducing a UK equivalent of the Market Stability Reserve**.

Secondly, **the UK ETS should aim for linkage to the EU ETS**. This produces three key benefits:

- **Ease of compliance** - UK companies exporting to the EU would not have to produce new documentation of compliance with EU rules.
- **Improved liquidity** - being part of a bigger market means greater opportunity for the trading of emissions allowances between more industry players, creating a more dynamic carbon market. In its initial years, the UK market has suffered from lower liquidity in comparison to the EU.
- **Exemption from EU CBAM** - in the case that the price under the UK ETS is lower than that of the EU, UK exporters to the EU would have to top up to the EU's price in the event of a CBAM. This money would then be paid to the EU rather than the UK Government. Aligning the UK ETS price to the EU's would help to mitigate this.

The ETS is the cornerstone of the UK's industrial decarbonisation approach and is a critical tool in supporting decarbonisation domestically. However, it heightens the risk of carbon leakage, or offshoring of high carbon processes to markets with a lower carbon price.

This needs to be addressed through a Carbon Border Adjustment Mechanism (CBAM), along the lines of that being implemented by the EU and described in Chapter [2]. Reporting for the EU CBAM will begin in October 2023, with implementation coming in 2026.

We recommend that the UK Government implement a CBAM no later than 2026 to align with the EU timetable. The Government should mirror the EU CBAM in order to deliver simplification and reduce compliance costs for UK firms. The CBAM should cover the broadest range of sectors possible that also participate in the UK ETS.

Getting CBAM and ETS design correct are vital for (a) ensuring that there is a clear business case for UK industry to invest in decarbonisation and (b) creating a level playing field with other markets internationally.

Mandatory Product Standards (MPS)

The interventions described around electricity prices, the ETS, and CBAM are designed to ensure the supply side of low carbon industrial goods can be commercial and competitive, a critical component of any industrial strategy. Equally important is ensuring the demand drivers are in place for low carbon goods, which are needed to ensure there is business confidence in being able to develop revenue streams on the back of investment into decarbonisation.

Mandatory Product Standards (MPS) are an important tool here. MPS would ensure that there is a clear long-term demand for goods with low levels of embodied carbon, therefore incentivising industry and manufacturing to invest in decarbonisation. In order to be effective, **MPS should prescribe a carbon footprint based on lifecycle emissions and include Scope 1, 2 and upstream Scope 3 emissions where possible.** Subject to close consultation with sector experts, **these standards should apply to a wide range of products in the UK market, including imported goods, to create a level playing field**. The Government should set a clear timeline for reducing the prescribed lifecycle emissions in manufactured goods to drive greater investment and innovation.

There are certain industries where greater pragmatism around setting standards is required. Industries such as ceramics and cement, where the tools for deep decarbonisation are not close to being rolled out or commercialised, will require some time and wider policy support before they can comply with stringent low carbon standards. It is therefore critical that the Government invests in vital infrastructure, such as for CCUS, to ensure that deep decarbonisation is a viable option for these sectors.

Green Public Procurement

In order to further support a market for low carbon goods, the **Government should use its own procurement as a tool to boost demand for products which meet MPS**, therefore providing an even greater signal to industry firms and investors.[79] The Government spends nearly £300 billion on procurement and is a significant customer for industrial goods across

several key departments, including defence and transport. By requiring or incentivising products which meet certain standards, the Government can help to provide assurance of demand for investors and businesses. This would help to reduce industrial sector emissions and boost the competitiveness of UK green industries.

Circular economy

As the industry decarbonises in the coming decades, deep decarbonisation measures such as CCUS, hydrogen, and electrification will be required to do much of the heavy. As set out in Chapter [1], there remain significant gains to be had from greater resource efficiency in the coming decades. Furthermore, improving the availability of scrap metal is a vital prerequisite to being able to electrify the steel sector, given that EAFs cannot be used to produce virgin steel from iron ore. In addition to environmental benefits, the economic and strategic benefits to the UK of making better use of its resources are significant and could be a game changer in improving the resilience of UK industry. A greater emphasis on circular economy approaches and resource efficiency is required to unlock these benefits.

The Mandatory Product Standards approach set out in the previous section should help to drive better resource use across industry and manufacturing. In addition, **the Government should urgently implement the interventions outlined in the 2021 Resources and Waste Strategy**, including accelerating the rollout of Extended Producer Responsibility schemes. As a holistic step, the **Government should also ensure that Resources and Waste policy becomes a cross Government priority**, with different government departments, including the Cabinet Office and HM Treasury contributing to policy development and implementation in this space.

CHAPTER 6

Call to arms

Net zero presents a substantial opportunity for economies across the world, something that is being increasingly recognised by the US, EU, and China. The UK also has the potential to secure the benefits of growing global markets for green industrial goods if it takes the bold measures required to seize this opportunity.

Conversely, If the status quo is allowed to continue, the UK could be facing deindustrialisation by default in order to achieve the transition to net zero by 2050. Heavy industry, which could all but disappear, is a critical part of the UK economy and society, providing employment, supply chain resilience, and supporting wider economic activity across a multitude of sectors. To lose these benefits would be a huge blow not just to the economy but to the UK's domestic supply chain, regional job provision, hopes of levelling up and, in the case of competitive trading sectors, international prestige.

Heavy industry in the UK faces a range of challenges in achieving the 'deep decarbonisation' necessary through a variety of approaches and technologies, some of which need significant innovation and investment to be viable. Existing comparative advantages in some sectors, including beverages and chemicals, will be eroded if this deindustrialisation is permitted, and the prestige that comes with them. Policy support is essential to delivering the change needed, especially given the large-scale support being provided to international competitors for these sectors, particularly in the EU and the US.

This report has laid out the significant benefits to the decarbonisation of industry without deindustrialisation. We are calling for the Government to launch an industrial strategy to maintain these benefits and achieve even greater heights for UK industry before the process of deindustrialisation becomes irreversible.

Annex 1: Methodology

As part of this research we conducted several pieces of analysis to gain a deeper understanding of the economic and trade value to the UK of the sectors we have defined as heavy industry, In order to study these sectors, we defined them as any non-fossil fuel sectors which had a concentration of CO2 per person per year above 25 tCO2, as well as those sectors historically recognised as heavy industry sectors even if they did not meet this criteria. This sector definition was used in the economic analysis, scenario forecasting analysis and the comparative trade analysis.

Economic benefit and scenario analysis

Data used in the modelling – sectoral gross value added (GVA) and sectoral GVA estimates by ILT1 (which gives regional distribution of GVA) obtained from ONS; employment data from ONS Business Register and Employment Survey and Northern Ireland Statistics and Research Agency, total greenhouse gas emission by industry section and group from ONS, long-term GDP and employment projection from OBR, long-term baseline and balanced net zero GHG emissions from CCC.

This data was first used to assess indirect and induced GVA and employment in the present day, including geographic distribution, to get the total economic impacts of these sectors.

Four scenarios were then constructed to reflect plausible pictures of different policy interventions:

- Deindustrialisation by default,
- All heavy industry investment,
- Investment in strategic industries,
- Investment in competitive industries

In order to assess the impact on GVA and employment under different scenarios, we have constructed a baseline scenario, which is a hypothetical 'business as usual' scenario where there is no consideration of emissions and no intervention on emissions. The GHG emissions trajectory of each selected heavy industry is assumed to follow the out-turn and baseline scenario of the CCC in its 6th Carbon Budget up to 2050. The GVA and employment projection of an industry is assumed to follow its historical share to the whole economy.

For scenario 1 deindustrialisation by default, it is assumed that there is no additional investment in heavy industry, and therefore no improvement in energy efficiency or adoption of low-carbon solutions. Meanwhile, emissions requirements are in place to achieve net zero by 2050. Each industry's emission trajectory is mapped to the CCC's balanced net zero pathway, while emissions per £1 million of GVA produced are assumed to remain the same as in the baseline scenario. As a result, GVA falls sharply towards 2050.

Scenario 2 is the flip side of Scenario 1, assuming that the heavy industries have received sufficient decarbonization investment to produce and maintain their market share as if there were no emissions constraints. As a result, the GVA and employment projections are expected to follow the baseline scenario.

Scenarios 3 and 4 are variants of scenarios 1 and 2, with different industries expected to receive an investment boost and decarbonise, while some are expected to deindustrialise. In Scenario 3, industries of strategic importance include all chemicals, glass and ceramics, iron and steel and cement industries. In Scenario 4, industries with comparative advantage are derived using the Revealed Comparative Advantage approach and the Green Growth Index.

Comparative Advantage Trade Analysis And Future Growth Index

In order to understand what advantages Britain holds in international trade, we used a Revealed Comparative Advantage methodology, where the outputs of the trade system are used to compare UK performance with international performance. We have kept the focus of competition global, comparing UK exports of a good to world exports of that same good.

The Revealed Comparative Advantage index measures the comparative advantage of each country-sector in global trade. Commonly referred to as the Balassa index (Balassa 1965). The value of the index for each country-sector is given by:

$$RCA_{is} = \frac{e_{is}}{\sum_s e_{is}} / \frac{\sum_i e_{is}}{\sum_s \sum_i e_{is}}$$

Where RCA is the index value calculated for each country i and sector s. The numerator measures the share of exports in a country-sector relative to total exports from that country. The denominator is the share of exports by the sector globally relative to total exports globally, for all countries in the sample. This effectively captures a country-sector's comparative (dis)advantage relative to the other countries in the sample, in our case, the world. The index is calculated using international trade data from the United Nations (Comtrade) database.

All those country sectors which had a revealed comparative advantage index score above 1 were considered to have a relative comparative advantage, and those below to have a relative disadvantage.

To understand the future trade performance of these same sectors, we used the findings of the Oxford Economics and Lloyds Banking Group's Green Growth Index which explores how well placed the UK's nations and regions are to capitalise on the opportunities of the green economy. Each sector was given a weighted average score based on the regional distribution of its GVA, and the corresponding green growth index score for each region. This captures the different geographic contexts the industries are facing, and therefore their unique mix of challenge and opportunities based on this geographic distribution. Any score above 50.0 indicated the likelihood of improving trade performance in the future due to a balance of opportunity over threat, and vice versa for any score below 50.0.

Endnotes

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6 Paper is also foundation sector, and is covered under the trade analysis

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69 A location quotient is a way to measure how much a region specializes in a certain industry compared to the whole country. It looks at how much of the industry's business is in the region compared to the whole country. The calculation is as follows:

1) Determine the industry's share of total economic activity (such as employment or revenue) in the region.

2) Determine the industry's share of total economic activity in the larger geographic unit (we're using the entire country).

3) Divide the industry's share of economic activity in the region by the industry's share of economic activity in the larger geographic unit.

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