Briefing

Decarbonising the cement industry

February 2025

green alliance...

Summary

The cement industry will play a vital role in meeting the government's aims to deliver economic growth across the country via new railways, homes and offices; support industrial sectors outside London and the south east; and cut greenhouse gas emissions.

However, cement manufacturing is responsible for 1.5 per cent of the UK's total annual emissions, a contribution that has remained above one per cent since 1990, and is significant for just one industry.

Most emissions from cement production come from clinker, an ingredient created when limestone is heated, releasing its stored CO_2. As this is a largely unavoidable part of what is a highly energy intensive manufacturing process, decarbonising the cement industry is challenging, with greenhouse gas emissions remaining stubbornly high.

There are many promising options for the industry, including lower carbon alternatives to clinker, switching from coal to fuels generated from waste, electrification and reducing the amount of cement used. However, the option that offers the highest potential emissions reduction is carbon capture and storge (CCS). Many cite cement as an example of why CCS technology and infrastructure are essential, however CCS for the cement industry is still a nascent technology, with many hurdles to overcome before it is a viable solution.

Despite the challenges, decarbonising this industry is an opportunity for the UK to emerge as a global leader in low carbon cement as demand for it increases worldwide. The technology and skills required have great export potential.

But to seize this opportunity the UK must pursue multiple solutions, with the government playing a vital role. Potential policy options to drive decarbonisation include setting a sector emissions target to direct necessary resources towards developing and scaling up technologies, as well as supporting an effective carbon price to encourage investment in expensive, but lower emission operations. Sector ambition would also be driven by improving construction regulation to build demand for greener cement.

About cement

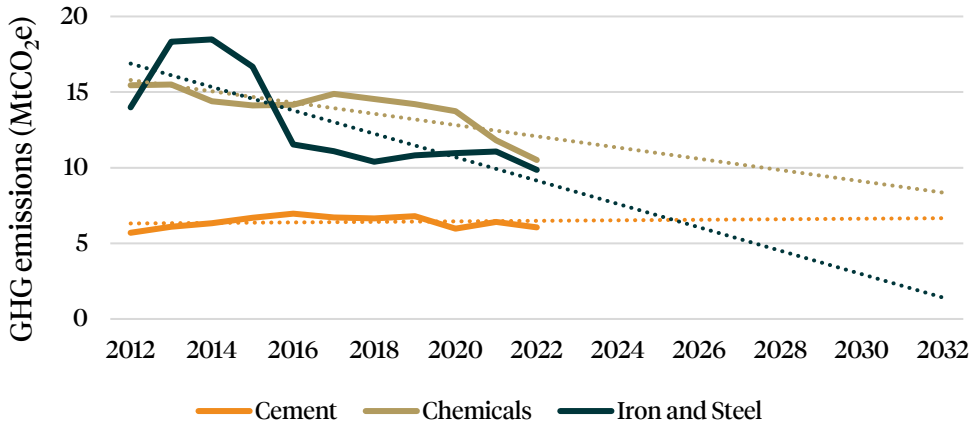
Cement is an important material in the UK construction industry. It is a binding agent made from minerals, mostly limestone. The most commonly used type is Portland cement or CEM I, but other combinations of materials can be used to produce cements with different characteristics. Most cement sold in the UK is used to make construction products such as concrete and mortar. Only seven per cent is used for other purposes, such as soil stabilisation, ie altering the properties of soil to make it suitable for applications like road foundations.[1]

Due to the chemical processes involved in making cement, the industry is a high emitter of greenhouse gases. In 2022, cement manufacturing alone was responsible for 1.5 per cent of the UK's total emissions.[2] As the UK's population is expected to increase by ten per cent by 2040, cement will continue to play an integral role in expanding and developing the UK's towns, cities and transport.[3,4] It will also be necessary to build the infrastructure needed to reach net zero, for example, wind turbine foundations require significant amounts of cement.

However, progress on emissions reduction is slow. According to the Mineral Products Association (MPA), from 2012 to 2023, the emissions intensity of cement has decreased by only 1.2 per cent. Operating with low margins and growing construction demand means the industry has adopted a risk averse stance to decarbonisation. Investment in newer solutions or those that require high upfront costs has been minimal.[5]

Lack of progress in reducing emissions also means the cement sector may already be a larger emitter than the energy intensive steel industry, especially given the ongoing electrification of UK steel production, and is on track to equal chemicals within the next decade.

Emissions trends of high emitting manufacturing industries[6]

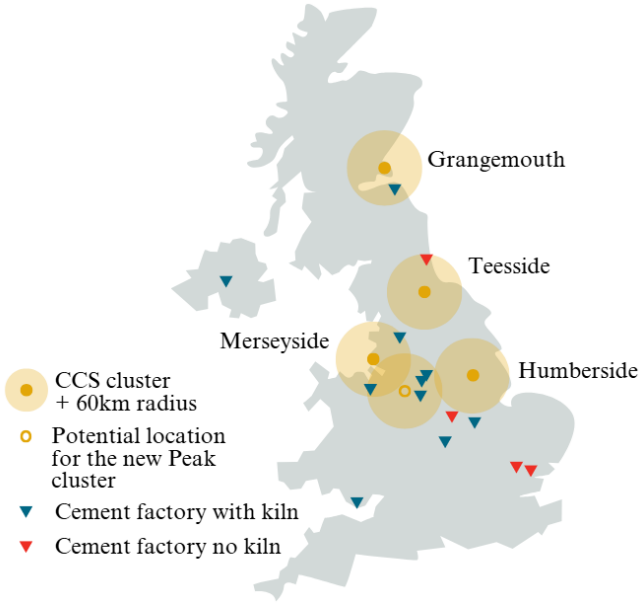


The industry supports the UK economy, with cement and related products contributing £3.6 billion, or 0.2 per cent, to the UK's gross value added (GVA) in 2023.[7] It sits within the wider mineral products industry which directly

employs 80,000 people and indirectly supports an additional 3.2 million jobs, primarily in the construction sector.[8]

The UK is not heavily reliant on cement imports as it produces around 80 per cent of the cement and 95 per cent of the concrete it uses.[9] Domestic production mainly comes from six major manufacturers; these companies operate 14 cement plants, ten of which operate high temperature kilns. Most emissions from cement production come from kiln operation and the calcination process (described below). The distribution of plants is shown in the following map. All but one of the six companies have set net zero commitments for 2050, with three (Breedon Cement, Heidelberg Materials and Holcim) verified by the Science Based Targets initiative (SBTi).[10]

Location of cement plants and Track-1 and Track-2 carbon capture and storage clusters across the UK [11]



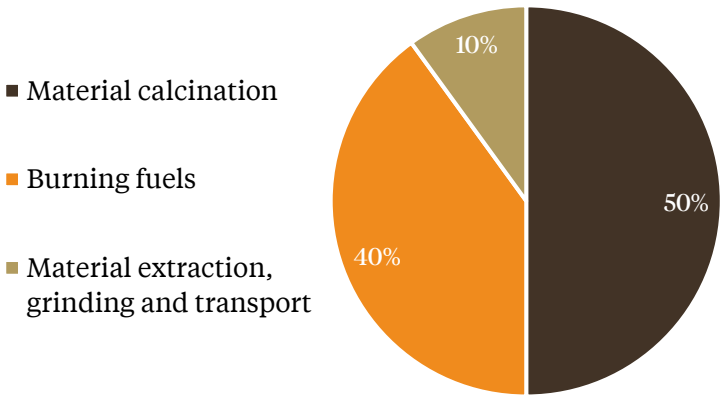
Where cement emissions come from

Cement is used to make a range of products, mostly for the construction sector. Concrete accounted for over half of domestic sales of cement in the UK in 2022.[12] Cement is concrete's emissions intensive ingredient; although it is only around ten per cent of the final concrete mixture, it accounts for around 90 per cent of the emissions during the manufacturing process.[13,14]

The production process and emissions sources

Step	Emissions source
1. Raw materials, including limestone, sand and other minerals, are mined and crushed	Fuel and electricity for machinery used in crushing and transport
2. Materials are preheated to around 900˚C	'Calcination' as CO_2 separates from limestone when it is heated
3. Materials are then heated in large rotating kilns to around 1,450˚C. The heat breaks down the materials and creates chemical bonds to partially fuse them together into 'clinker'	Fuel combustion to operate the kilns, fans and motors
4. Clinker is cooled, ground to a powder, and mixed with gypsum (another mineral) to form cement	Fuel combustion to operate the machinery
5. Cement is stored and dispatched	Fuel and electricity use in storage and transport

Emissions from cement production[15]



Calcination contributes around half of the cement industry's greenhouse gas emissions, though industry statistics suggest it could be up to 70 per cent. This highlights difficulties in decarbonising cement production, as most emissions are due to the main material input and chemical process.

It is not only cement that poses this challenge, as parts of the steel, chemicals and glass industries also rely on the calcination of limestone in high temperate kilns.

Decarbonisation options

In 2023, UK cement manufacturing emissions were between 530kgCO_2 and 770kgCO_2 per tonne of cement, depending on the materials, machines and fuels used.[16] The average was 650kgCO_2 per tonne.[17]

There is a wide range in the maturity and scalability of options available to tackle these emissions. They involve either changing the materials used, targeting emissions associated with processes or reducing cement demand. The global and national emissions reduction potential of each is summarised below.

The emissions reduction potential within the cement making process

	Solution	Emission reductions		
		By 2030, globally[18]	By 2050, globally[19]	By 2050, UK[20]
Material selection	Clinker alternatives	6%	9%	21% (shared with lower demand)
	Enhanced CO_2 absorption	8%	6%	
Manufacturing emissions	Carbon capture and storage (CCS)	2%	36%	58%
	Alternative fuels	11%	16%	13%
	Electrification			2%
	Improved energy efficiency	4%	11%	
Reducing demand	Includes concrete recycling, design optimisation, and construction efficiencies	6%	22%	21% (shared with clinker alternatives)
Total		37%	100%	94%

Changing materials

- **Reducing the 'clinker factor' with substitute materials**

  Emissions can be reduced by decreasing the amount of clinker used per tonne of cement (the 'clinker factor') and replacing it with substitutes. These are known as supplementary cementitious materials (SCMs). Common SCMs used by UK manufactures include ash and slag, byproducts of coal power generation and traditional steel production, which are both declining.[21] As the availability of these will decrease, alternatives that are commercially viable, ie easily and locally available, are needed to meet long term decarbonisation targets. But construction and architecture industries' reluctance to adopt new materials means rollout could be slow.

- **Enhanced CO_2 absorption**

  Cement and other limestone-based materials absorb carbon from the atmosphere during their use in a process known as carbonation. This can be enhanced through material and design choices.

Targeting manufacturing emissions

- **Carbon capture and storage (CCS)**

  This involves directly capturing the carbon emitted during the calcination process (see step 2 in the table above) or from the burning of fuels, or both. Captured carbon is then transported to a site where it is stored underground. CCS is one of the most popular solutions for the cement industry as it can address both calcination and fuel related emissions, which no other single decarbonisation option can eliminate entirely. However, it requires expensive retrofit of existing plants and new CCS-ready plants to be built.

  CCS upfront capital investment costs vary between £150 and £510 million and will depend on the technology used, the plant's location and how it will transport captured carbon to the storage site (transport by road or rail is more expensive than via pipelines).[22] CCS is also unlikely to be deployed at scale in the cement industry before 2030 and is limited by a plant's distance to a carbon storage site (see map above).

  One CCS cluster, known as the Peak Cluster, has been proposed to capture and store emissions from the cement and lime industry in Derbyshire and Staffordshire. It is currently at the stage of design,

consultation and obtaining consent. Construction is planned to begin in 2027 with the aim of being operational in 2030.[23]

- **Alternative fuels**

  Traditionally, the cement industry has been powered by coal, but waste derivatives are becoming an increasingly common fuel source. For example, discarded tyres and non-recyclable plastics can be used which are not low carbon, but which would otherwise be incinerated or landfilled.

  Other options include lower carbon biomass fuels. Although biofuel technology exists, constraints on the supply of biomass limit its potential for use in cement making.

  Hydrogen fuel for heating is also being explored but is still in the early stages of development and is reliant on a supply of low cost, low carbon hydrogen. Some manufacturers in the UK have committed to switch to hydrogen as early as 2026.[24]

- **Electrification**

  Electrification options for cement kilns include heating them with electrically generated plasma or using microwaves. These technologies are capable of heating air to 3,470˚C, sufficient for cement production. However, they are still in the early stages of development and adoption and so may play a larger role beyond 2030.[25]

  Heating kilns for cement production is energy intensive so, to be low carbon and commercially viable, electrification will depend on access to cheap, renewable electricity, as well as sufficient grid capacity.

- **Energy efficiency**

  Multiple efficiency solutions have already been adopted industry-wide which means there is not much more progress to be made. Solutions include the use of dry process kilns which use less energy than wet kilns as there is no need to evaporate the water, and multi-stage preheaters which provide a gradual and less energy intensive temperature differential. Other options include adding mineralisers to clinker to reduce the temperature at which it melts.[26] Any additional solutions that could still be adopted depend on the current operations and conditions at a plant.

Reducing cement demand

- **Avoiding overspecification**

  Overspecification, which is the practice of using more material than is required, is commonplace in construction and can range from 25 to 50

per cent more materials than are needed being specified. Green Alliance analysis shows that optimising material use in the design phase of projects is an effective way to tackle this, especially for concrete.[27]

- **Use of lower carbon materials**

  Increased use of more sustainable materials in construction, like timber, reduces cement demand, but applications are limited. Many smaller scale projects are developing alternative lower carbon construction materials, creating opportunities for the most promising options to develop and mature.

- **Concrete recycling**

  Demolished concrete structures can be repurposed as aggregate, as well as used for clinker production, reducing calcination emissions. However, this involves decontaminating demolition waste which is energy intensive. Supply chains for recycled concrete are well established and most concrete waste is recycled in the UK.[28]

Major manufacturers' sustainability reports suggest the bulk of emissions reduction efforts across the UK's industry so far have come from the adoption of alternative fuels and reduction of the clinker factor. Continued reduction in the clinker factor, as well as use of CCS, are the most common solutions mentioned in industry emissions reduction plans.[29]

Considering around half of the plants are dispersed away from proposed CCS clusters, CCS is more likely to play a role in decarbonising cement closer to 2050, when there has been enough time for CCS technology and infrastructure to mature and expand. For the industry to play its part in helping the UK to reach its 2050 net zero target, more investment is needed in the near term to support the use of proven and promising solutions like clinker alternatives, alternative fuels and electrification.

Further, industries like cement have long investment cycles, with factories and assets lasting decades; in the UK, the most recently constructed cement factory was built in 1968.[30] This means investment in lower carbon operations must happen now to ensure the right infrastructure is operational early enough in the future.

Policies affecting the industry

Existing policy

Targeted support for the cement industry is limited. The 2021 industrial strategy set a target for industrial emissions to be reduced by two thirds by 2035, and suggested CCS and biomass fuels would be major solutions for the cement sector.

The policies to deliver those ambitions include: government support via **UKRI's £3.2 million investment in seven projects** focused on the decarbonisation of the UK's concrete industry; the **Industrial Energy Transformation Fund** (IETF) which awarded over £7.5 million to five projects in the cement and concrete sector in its latest phase of grants; the **British Industry Supercharger** which aims to reduce electricity costs for energy intensive businesses, including those in the cement sector; and a **commitment to spend £21.7 billion on the first set of CCS projects**, which includes a cement plant in the HyNet cluster. [31,32,33]

Although there is some funding for the sector, regulation of the industry's emissions is insufficient and is softened by efforts to avoid 'carbon leakage' (ie the risk of being undercut by higher carbon imports).

The **UK emissions trading scheme** (ETS) is a 'cap and trade' system for greenhouse gas emissions applied to high emitting sectors, including cement. Sectors deemed at risk of carbon leakage are given a portion of their allowances for free. The number of carbon allowances available will drop by 65 per cent to 2030, from 69 million in 2024. Although the UK ETS should be an incentive to invest in lower emission processes, the market price for allowances is currently too low. Alongside free allocations, this further reduces the incentive to invest in carbon cutting technologies with high upfront costs, as the emissions savings from these investments do not equate to significant financial savings.

The **Climate Change Levy** is a tax on businesses' gas and electricity supplies. The cement sector is exempted from the levy to maintain tax rates competitive with the EU's.

As with all large businesses in the UK, cement companies are subject to the **Energy Savings Opportunity Scheme** (ESOS) which requires them to conduct an energy assessment of their operations, but there is no requirement to act on the recommendations.

Proposed and forthcoming policies

The coming years present multiple opportunities to strengthen regulations to encourage and support the decarbonisation of the cement industry.

Carbon Border Adjustment Mechanisms (CBAMs) ensure equal treatment of domestic and imported goods. They avoid the risk of carbon leakage by applying a cost on carbon for some imported carbon-intensive goods. An EU scheme covering cement enters into force in 2026 and a UK scheme is due to start in 2027. An open government consultation, due to close in March 2025, is seeking views on whether and how to phase out free allocations in sectors covered by a CBAM.

A new **industrial strategy** will be published in 2025, and an **industrial decarbonisation strategy** will come in 2026. A green paper published towards the end of 2024, setting out the government's vision for its upcoming industrial strategy, acknowledged the importance of foundation sectors like cement and highlighted the importance of electrification.

Policy recommendations

To secure the future of the UK's cement industry, in a way that enables emissions reductions and protects jobs, stronger policy is needed.

Many policy gaps exist, including on the demand side where cement makers need more reassurance that there is a market for lower carbon materials. Further, investment in lower carbon processes is deterred by inconsistencies in financial support and uncertainties around UK ETS prices.

A strong industrial strategy could allow UK manufacturers to reclaim market share at a time when the industry is warning of growing competition from abroad and a lack of investment in the UK by multinational companies.

Retaining this industry is worthwhile for the government's growth mission as workers in the mineral products industry add 1.5 times higher than average economic productivity.[34]

A futureproofed cement sector is also essential to underpin the long term success of the government's forthcoming infrastructure strategy and developments in many of the other sectors being targeted by the industrial strategy.

For the upcoming industrial strategy, we recommend:

- **A near zero emissions 2040 target for the cement industry and an accompanying roadmap to guide future investment and policy decisions.**[35]
- **Continued commitment from the government to build CCS infrastructure, with a focus on sectors like cement where there are fewer alternative routes to decarbonisation, and collaboration with industry to connect dispersed sites to carbon storage points.**
- **More investment for research into clinker alternatives, eg via UKRI.**
- **Using public procurement to directly support the use of low carbon cement.**

We also recommend:

- **Increasing UK ETS carbon prices** as an incentive to invest in lower carbon processes and achieve faster decarbonisation. This could be delivered through a rising trajectory for the auction reserve price, the minimum price at which allowances can be sold at auction, or by removing surplus allowances from the market. It should also be aligned with the EU ETS.

– **Lifecycle emissions reporting requirements for major construction projects, followed by mandatory standards,** aligned with proposals by the industry-led Part Z campaign. This would drive uptake of lower carbon solutions, helping to bring down their price over time, and incentivise resource efficiency.[36]

For more information, contact:
Amira Jamal, policy analyst, Green Alliance
ajamal@green-alliance.org.uk

Endnotes

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