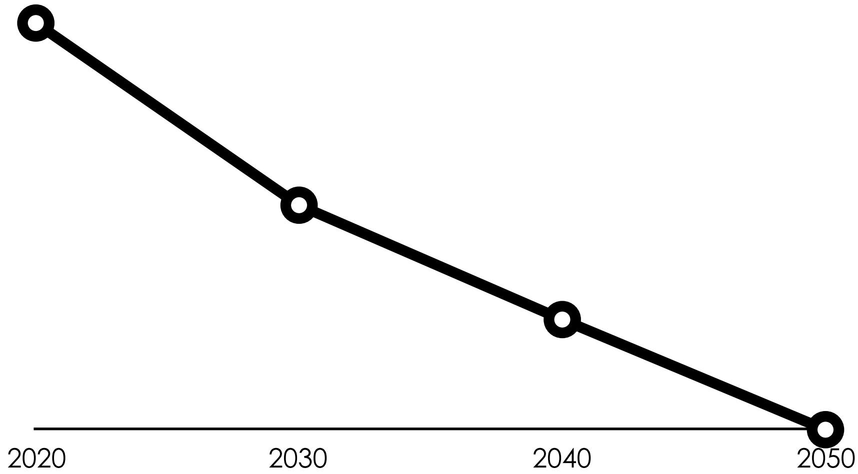
EXPLORING NET ZERO

Energy&Climate INTELLIGENCE UNIT

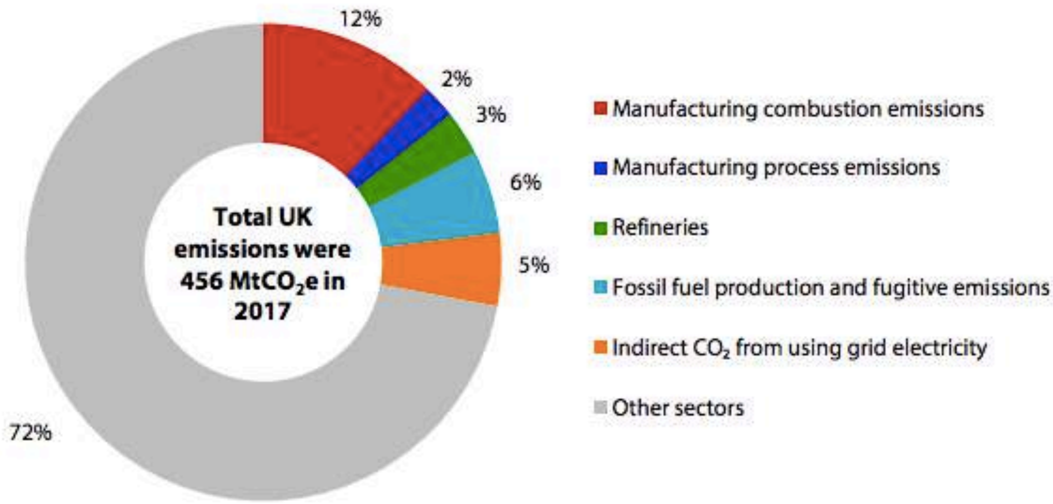


Heavy industry and the net-zero economy

Industry accounts for about one-quarter of the UK's greenhouse gas emissions.

More efficient manufacturing practices, higher recycling rates, electrification, hydrogen, renewable power and carbon capture can together help cut industrial emissions by about three-quarters by 2050. Innovation is likely to bring more options.

Current emissions and energy use



Source: BEIS (2018) *Provisional UK GHG national statistics*, BEIS (2018) *Energy Trends*, CCC analysis.
Notes: 2017 emission estimates are provisional. Percentage figures may not sum to 100% due to rounding.

Direct GHG emissions from industry and indirect CO2 from grid electricity use as a share of total UK emissions (2017). Source: CCC progress report 2018

About half of industrial emissions can be eliminated through a wider-economy shift from fossil fuel use to clean energy. Generating all electricity from zero-carbon sources will eliminate grid-linked CO_2 emissions.

Producing and refining oil and gas leads to 40% of direct industrial emissions. Ending their use as an energy source will substantially reduce this, as they will only be needed for industrial applications such as making plastics.

The remaining 60% of direct industrial emissions comes from manufacturing. Here we look at four of the main industrial emitters – steel, cement, chemicals and aluminium.

Steel

Iron and steel account for 17% of UK industrial emissions. There are huge opportunities to reduce this on both the supply and demand sides.

All future growth in demand for UK steel could be met through recycling. Recycled steel is made using electric arc furnaces – which produce no carbon emissions if the electricity comes from renewables or nuclear. By contrast, making virgin steel uses iron ore mixed with coal.

Careful disassembly of old products to separate steel from other metals means it can be upcycled into higher-value products; the volume of steel available for recycling will treble in the next 30-40 years.

Recycled steel is made using electric arc furnaces.
Image: Mouser Williams, creative commons licence

Cleaning up virgin steel production is also possible. Replacing sinter, the form in which iron ore is fed into the blast furnace, with pellets could reduce CO_2 emissions significantly. A Swedish consortium is trialling the use of hydrogen to replace coal.

Cement

Cement contributes about 10% of direct UK industrial emissions. The industry has already cut emissions by more than 55% since 1990, and has analysed how to reduce them by 81% by 2050.

More than half of emissions come from the process of producing clinker, the main ingredient in cement, from ingredients such as calcium, silicon and iron. Reducing clinker content by 70% is feasible, and could save about three-fifths of projected cement emissions globally in 2050 at very little cost.

The process of producing clinker itself can also be made cleaner by using ingredients such as graphene, and by substituting the fossil fuels – mainly coal – used to power cement kilns. Improving energy efficiency would also curb emissions – European and US cement plants are less efficient than those in China and India.

A more radical solution is carbon-negative concrete, which absorbs more carbon dioxide during hardening than is released during production. A number of companies are close to bringing a product to the market.

Using higher quality concretes, alternative building materials and being more efficient on-site could reduce demand and hence emissions by more than 50%. Partially hollow structures could possibly reduce concrete use by 70% without compromising structural integrity.

Chemicals

The chemicals industry contributes about 12% of UK industry's direct emissions. It produces a wide range of substances – therefore there is not a 'one-size-fits-all' solution.

Improving efficiency is relevant across the sector. The process that consumes the most energy is steam cracking to produce light olefins, one of the two main petrochemical groups. Upgrading to the best available technology could reduce energy intensity by almost a quarter.

For some end-products a big opportunity is bio-processing, which uses biological systems to make products. This is currently expensive, however, and there are concerns about availability of the biological materials. Separating chemicals with membranes rather than distillation and heating would also reduce emissions while saving companies money.

Aluminium

Aluminium accounts for about 1% of global GHG emissions. However, with just one production site in the UK, its contribution to UK emissions is small; on average, 70% of emissions associated with virgin aluminium production are from electricity, which can be reduced by using low-carbon supplies.

The biggest process emissions come from the electrodes used in smelting. They are made of carbon and give off CO_2 as they wear down. Industrial giants Alcoa and Rio Tinto have developed a replacement material that releases oxygen instead. They estimate it will be available commercially in 2024.

Carbon capture and storage

Possibly the technology with the biggest potential to reduce emissions across industry is carbon capture and storage (CCS).

Here, the CO_2 is captured before entering the atmosphere and stored underground. Alternatively, it can be used to make fuel, plastic or chemicals (carbon capture and utilisation, or CCU). Most research and development has been in the power sector, but industry is catching up.

Sask Power's Boundary Dam power plant in Canada was the world's first commercial scale CCS plant. Image: Sask Power, creative commons license

Following a successful trial, work is underway on the world's first full-scale cement carbon capture plant, in Norway. Work has also begun on a next-generation technique where CO_2 is separated and captured at source, known as process-integrated carbon capture. This should prove much more cost effective.

In the UK, one study recommends establishing CCS clusters, where multiple emitters share CCS infrastructure as a way of cutting costs by two-thirds. One such proposed scheme is the Teeside Collective. The Government is investing up to £100 million in CCU and wants the UK to be an 'international leader' in the technology.

The potential

One study indicates that UK industrial CO_2 emissions could be reduced by up to 73% by 2050 using measures that are technically available today. Another put the figure at up to 68%, also concluding that industry would save £17-32 billion in the process.

New technologies developed in the coming decades will offer further opportunities for emissions reductions. The Government has launched a series of initiatives and action plans to help bring innovations forward. Any residual emissions could be balanced using negative emissions techniques.

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