Briefing

Policy barriers to greening the chemical industry

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green alliance...

Summary

Significant gaps in UK policy are making it harder for the chemical industry to remove fossil fuels from its supply chain and modernise for a green economy. The UK's emissions trading scheme and climate change levy provide impetus, and some companies have signed up to science based targets. Some downstream customers are also applying upward pressure on the supply chain to 'defossilise', but chemical manufacturers are not often in the public eye, meaning there is less incentive to cut emissions voluntarily than in other sectors.

Our analysis is informed by interviews with diverse sector stakeholders and our own research, including our previous study into the chemical industry and climate change.[1,2] We have formed a clearer picture of the status quo and the policy challenges. As we illustrate below, we have looked at six areas relevant to reducing the climate impact of the UK's chemical industry.

Overall, the outlook is worrying. Carbon capture and storage (CCS) and fuel switching from natural gas to hydrogen receive high levels of government support. However, we believe there is overreliance on too narrow a strategy and that a more diverse set of solutions is needed to match the sector's needs. These should include electrification, resource efficiency and the development of alternative feedstocks. Skills development and innovation also require attention as the necessary backdrop for these changes to take place.

Although we are critical of current policy, there are a wealth of opportunities for the government to make tangible changes to help this industry, alongside other industrial sectors, to accelerate emissions reductions and remain competitive.

Progress on green policies in the chemical industry

Policy area	Status
CCS and hydrogen	Industrial cluster projects are well funded and progressing.
Electrification	There are major barriers in affordability and grid connectivity.
Resource efficiency and circularity	There are major barriers and few incentives for change.
Alternative feedstocks	Alternatives are expensive, with no strategy or policy incentives to develop them.
Innovation	This is positive in some areas; ideas are created in the UK but few transfer into domestic chemical manufacturing.
Skills	There are large gaps in science, technology, engineering, and mathematics (STEM) specialisms and green skills.

Introduction

The chemical industry has been under the radar for too long, in terms of both its climate change impacts and the extent of its foundational role in modern life. The industry is complex and fragmented, with a few big multinational companies and many small and medium enterprises, making it difficult for policy makers to grasp. A unified industry voice is sometimes lacking.

Chemicals and their derivatives are ubiquitous, used in over 90 per cent of manufactured products and materials, including plastics, fertilisers and detergents.[3] But the sector contributes 19 per cent of the UK's industrial emissions and is heavily reliant on fossil fuels, both as a feedstock for making chemicals and as an energy source.[4] Critically, the industry underpins the economy's ability to decarbonise, as it is vital to many products necessary for the low carbon transition, including batteries, heat pumps and wind turbines.

We need a UK chemical industry. It supports around 140,000 direct highly skilled jobs, primarily located outside London and the south east.[5] Retaining it will give the UK greater power to eliminate virgin fossil resources from the value chain, and provide opportunities for growth. A plan for this industry should be part of a UK industrial strategy for economic resilience and a greener future.

The chemicals market is global, and the UK and European markets are highly interconnected and interdependent. Businesses in the UK risk rapid decline in the face of fierce international competition, given their comparatively high operating costs. This is illustrated by the contraction of the industry's output and employment figures in 2023, by nine per cent and seven per cent respectively, and by closures such as the shut down of CF Fertilisers' ammonia plants in 2022, citing high natural gas prices and rising carbon costs as the cause.[6] The company had investigated decarbonisation options but chose not to wait for UK government support for carbon capture and storage (CCS) developments. Instead, it chose to invest in the US, where it is headquartered and where the Inflation Reduction Act offered strong incentives for greener industry. Other large companies in the UK also operate in other countries and could follow suit, taking investment to wherever there is stronger and more consistent support for the net zero transition or other areas like innovation.

Cutting production emissions

CCS and hydrogen fuel

The government's strategy to cut emissions in the chemical industry has largely focused on using carbon capture and storage (CCS) and switching to hydrogen fuel. The government has committed £20 billion for the early deployment of CCS and £240 million for hydrogen capex funding, while also establishing a subsidy system for hydrogen production and CCS operations.[7]

CCS and hydrogen can often be integrated into existing systems with some adaptation and can be effective, but they need significant new infrastructure for transportation and storage. In the medium term, they are only likely to be viable for sites within, or close to, the four CCS clusters in current government plans (in the Track 1 and Track 2 phases). The three steam crackers in the UK that produce ethylene are a good example of where they could be used. These sites account for approximately a quarter of the chemical industry's emissions and are in the CCS clusters.[4] Their owners plan to use CCS (ExxonMobil in Fife) and hydrogen solutions (INEOS in Grangemouth and Sabic in Teesside).[8, 9, 10]

Some of our interviewees raised concerns over reliance on CCS technologies which are yet to be proven at industrial scale. While the separation of CO_2 from methane gas with amine solvents is a long established technology, there is limited evidence that the high efficiencies quoted (often at a rate of over 95 per cent carbon capture) will be achieved for other industrial processes and at the scale required. Long term safe and secure storage of CO_2 is also a very new industry. Even at high capture rates, CCS does not eliminate emissions.

Switching to hydrogen fuel has been touted as a good option for high temperature processes that are difficult to electrify. Opinions were mixed among the experts we consulted, with doubts expressed about hydrogen's

economic viability but, if the proposed hydrogen business models work as intended, they should alleviate cost barriers.

There were further concerns over the availability of hydrogen, given the competition with other decarbonising sectors and industries for the limited supply available. Blue hydrogen attracts the same sort of criticisms and risks as CCS, and green hydrogen is likely to be expensive and scarce for some time.

The Hynet and East Coast industrial clusters will start their first connections to CCS and hydrogen infrastructure around 2027, with two more coming online after 2030. This means many plants will experience long waiting times to get the technology up and running. There are concerns that, with high operating costs, rising carbon prices and international competition (between companies and within multinational companies deciding where to build new plants) some sites will not survive.

CCS and hydrogen: how to overcome barriers

Barriers	Solutions
➢ CCS technology is not yet proven at scale across all relevant processes ➢ CCS and hydrogen are expensive ➢ Hydrogen is a scarce resource ➢ Deployment lead times are long	➢ Ensure industrial cluster roll-out keeps pace with the demand for CCS and hydrogen ➢ Diversify the approach, with support for electrification, to reduce dependency on CCS and hydrogen ➢ Adopt a hydrogen use hierarchy, prioritising heavy industry

Electrification

Government energy consumption statistics suggest around 73 per cent of heat demand for chemical manufacturing is for low temperature processes (assumed to be below around 500°C) and most of these are not currently electrified.[11] This is a clear opportunity to exploit the government's ambitious 2030 clean power target to reduce chemical industry emissions.[12] It is especially crucial for dispersed sites which make up approximately a third of the industry's emissions and cannot readily rely on CCS or hydrogen solutions.[13]

There was widespread support amongst our interviewees for low temperature process and, in some cases, high temperature process, electrification. Low and medium temperature solutions, such as industrial heat pumps and electric

boilers are well established and relatively simple to deploy. High temperature processes, such as steam crackers, are more difficult to electrify but companies such as BASF, SABIC, Linde, Shell and Dow are now investing in electric crackers in other countries.

However, as recognised in the CCC's 2023 progress report, UK government support for electrification is poor compared to CCS and hydrogen.[14] Two big barriers to electrification are the price of electricity and often long waiting times for new or upgraded grid connections. Industrial electricity prices in the UK have been consistently higher than the EU average and were 23 per cent higher in 2022.[15] The grid connection queuing system is being reformed, but significant investment will be required for network capacity to get ahead of demand. There is also little capex support for companies to invest in electrification, beyond the Industrial Energy Transformation Fund (IETF). The recent British Industry Supercharger scheme aims to reduce the price of electricity for heavy industry but is unlikely to have much impact on the chemical industry as a whole. Only the largest chemical plants will qualify, many of which are in clusters, and qualification for the scheme depends on historic electricity use, rather than encouraging new electrification projects via guaranteed support based on future electricity costs.

Small modular nuclear reactors (SMRs) are seen, by some, as an alternative to the high costs of grid-based power. Plans for privately financed installation of four SMRs for the Teesside cluster were announced in early 2024. The provision of 'always on' energy suits many continuous chemical processes but may still need a backup grid connection. While opinions on SMRs were positive among our interviewees, without any being in full operation yet it is unclear whether they will be developed as quickly or as economically as claimed. An indicator of this could be the delays and high electricity strike price agreed for Hinkley Point C, which have not boosted confidence in nuclear power.

Another alternative is renewable energy power purchase agreements (PPAs). These typically take the form of a long term contract between electricity generators and large business consumers, with durations of up to 15 years. They are seen as a route to stable, lower electricity prices without being subject to the marginal pricing structure of the wholesale market. But there are two main challenges to further uptake of PPAs in the chemical sector. First, some manufacturers may struggle to adequately demonstrate long term viability for extended contracts. Second, PPA prices are increasing because there is a shortage of generators, with most new developments opting to compete for contracts for difference (CfDs). Thus, there is more demand for renewable energy supplied via PPAs than generators can offer, and much of the demand comes from other sectors, such as large supermarket chains, who are willing to pay a premium for low carbon electricity.

Electrification: how to overcome barriers

Barriers	Solutions
➢ High electricity prices ➢ Long grid connection delays ➢ Small modular nuclear reactors are costly or high risk ➢ Power purchase agreement (PPA) prices are increasing and the market is difficult to access	➢ Expand eligibility for the British Industry Supercharger scheme ➢ Invest in cutting grid connection delays ➢ Underwrite PPA contracts and support bundled contracts

Resources and feedstock solutions

Efficiency and circularity

Demand reduction, circularity and increased resource efficiency will cut the use of fossil fuels, reduce emissions and lower the need for expensive, energy intensive alternative feedstocks.

Approaches should focus on the highest levels of the waste hierarchy, ie targeting reduction first (minimising demand and waste before it is produced). Policy progress has been glacially slow with poor implementation incentives. The government should adopt a strategic approach to cut demand for chemicals and the generation of waste, including plastics, and ensure there is adequate domestic recycling capacity.

A direct way to reduce waste and the need for virgin feedstocks is to increase the use of by-products. It was clear from our interviews that a major barrier to this is the unnecessary classification of by-products as waste in the absence of an existing market for them. Our previous work suggests it is not the waste definitions, as such, that are the problem, but the overly stringent and non-collaborative nature of their implementation by regulators, which limits, instead of encourages, greater innovation.[16] The government is starting to recognise this as an issue. The Environment Agency, although covering England only, is reopening a service to reclassify waste which should help collaboration across industry.

Most of our interviewees broadly supported the adoption of a ‘mass balance approach’ (MBA). This is being considered for inclusion in the plastic packaging tax and is likely to be discussed for any future regulation on chemical feedstocks. MBA would allow alternative and recycled feedstocks to

be added to virgin feedstocks in existing chemical production processes. Materials would be tracked so non-virgin content can be allocated to end products based on the balance of inputs. Compared to building entirely new value chains and assets, using existing ones will help address cost and infrastructure barriers to the use of alternate and recycled feedstocks in the short term as the industry transitions.

However, environmental groups have urged caution over this approach, highlighting the danger that MBA could lock in continued high levels of single use plastic use through the incentive of chemical recycling.[17] Greenwashing is also a risk without clear standards and sophisticated tracking. Regulatory approaches must also ensure that, for the plastic production stream, mechanical recycling should always be the preferred approach, being more energy efficient and cost effective. MBA should be implemented carefully alongside a plan to manage long term recycling infrastructure and the use of alternative feedstocks by the chemical industry.

Resource efficiency and circularity: how to overcome barriers

Barriers	Solutions
➢ Value chain complexity ➢ How waste classifications are implemented ➢ Historic slow progress in implementing resource efficiency policy	➢ Create a demand reduction strategy ➢ Fully embrace circular economy opportunities in the upcoming roadmap to zero waste ➢ Carefully implement a mass balance approach ➢ Expand initiatives for resource efficiency and an industry-regulator collaboration ➢ Stimulate market innovations via public procurement ➢ Industry should develop alternative business models, eg chemical leasing

Alternative feedstocks

Sixty three per cent of all chemicals are carbon-based; of these, 90 per cent by mass contain carbon from fossil sources. Using fossil sources entails large upstream emissions, and embedded carbon is eventually released to the

atmosphere, over varying timescales. The industry should work towards replacing some, if not all, of its fossil feedstocks with alternatives for long term climate security.

Ethylene is the primary chemical produced in the largest quantities in the UK. There are three main options for ethylene production using alternative feedstocks:

- carbon from chemically recycled plastic
- carbon from plant sources (biomass)
- captured carbon and green hydrogen

We explored the use of these alternatives in our report, *The last use of fossil fuels?*.[18] There was strong consensus in our interviews that all forms of alternative feedstocks will be needed in the future as there is no single, easy solution.

Alternative feedstocks to fossil fuels are generally more expensive and energy or land intensive, and the availability of hydrogen and biomass is limited because they will face strong competition from other sectors as the economy decarbonises.

No incentives exist to shift to alternative feedstocks and, in fact, the renewable transport fuel obligation and planned sustainable aviation fuel mandate both incentivise their use in fuels rather than in chemicals. Greenhouse gas emissions from degraded chemical products are classed as 'scope 3', ie as indirect supply chain emissions, which are not covered by the UK's emissions trading scheme (ETS).

Like resource efficiency, there is some, but limited, impetus for change, mostly driven by demands from industry and consumers. Some of our interviewees noted that the 'utilisation' part of the wider categorisation of 'carbon capture, utilisation and storage' (CCUS) has attracted little attention or incentives, despite being a relatively straightforward source of carbon. CCS regulations around the storage of captured carbon on site may even hinder the potential for its reuse.

Flue2Chem, a proof-of-concept project led by SCI and Unilever, collaborating with 13 industrial, academic and NGO partners across the supply chain, is a good example of an innovative project exploring this space. They aim to take waste gas from industry and generate an alternative source of carbon for producing end-use chemicals, like cleaning products. There are many lessons to be learned from this project, both technically, in its use of newer technologies, but more importantly from the regulatory barriers they faced, including around how captured carbon is stored, and competition rules for the £2.7 million funding received from Innovate UK. The project will publish its policy recommendations for the use of captured carbon in 2025.

Alternative feedstocks: how to overcome barriers

Barriers	Solutions
➢ Lack of policy direction ➢ High costs and resource intensive ➢ Limited availability of clean electricity, hydrogen and biomass ➢ CCS regulations limiting carbon reuse	➢ Implement a green carbon mandate for chemicals ➢ Better product standards and labelling ➢ Introduce more incentives for resource efficiency and stimulate market innovation via public procurement

Supporting measures

Innovation

In general, investment in UK businesses has been consistently low, with public investment below the average of the OECD and G7 and private investment ranking 27th out of 30 OECD countries.[19] Many industries are being attracted away from the UK by better conditions abroad, such as the incentives offered by the US Inflation Reduction Act. The challenge for the UK is how it can attract investment while simultaneously meeting its net zero targets. We highlight the need for an industrial strategy, which was strongly backed by our interviewees.

Industry innovation funding is provided through Innovate UK and the Net Zero Innovation Portfolio competitions, and through business investment incentives, such as R&D tax relief. Innovate UK has established the Catapult Network which offers expertise and facilities for businesses.

The prevailing opinion of our interviewees was that, between academic prowess and innovation funding, a wealth of ideas are being generated in the UK, but only a tiny fraction lead to products domestically manufactured at scale. This gap in the journey through technology readiness levels is sometimes referred to as the 'valley of death'. Some interviewees noted that funding streams tend to be short term, frequently shift and are usually tightly prescribed, rather than adapting to the needs of projects.

The High Value Manufacturing Catapult fosters collaboration between industry, the government and academics, and exists to bridge the 'valley of

death' at the manufacturing stage. It seems to function effectively, but its use is limited as it is a paid for service requiring already well funded projects.

There are many reasons why a company chooses to invest in one country rather than another, of which innovation support is just one. However, the limited understanding of these factors, and absence of long term joined up policy frameworks to address them, is why an industrial strategy would be so valuable. It should be accompanied by a complementary suite of adaptive innovation funding and support to create an attractive investment environment in the UK.

Innovation: how to overcome barriers

Barriers	Solutions
➢ Funding pots are complex, overly prescriptive and often too short term ➢ There is an innovation gap at the industrialisation stage	➢ Deliver an industrial strategy ➢ Restructure the funding available, aligning with strategy and prioritising simplicity and adaptability

Skills

If the UK chemical industry is to thrive through the transition to a green economy, it will need to employ the right people with the right skills. There was much concern amongst our interviewees about the significant skills gap. The chemical sector is especially dependent on an educated workforce, and approximately one in five jobs advertised in the industry are classed as 'green', compared to 2.5 per cent in the wider UK labour market.[20]

The 2022 Employer Skills survey showed an increase in areas of skills shortage, of 24 to 45 per cent between 2011 and 2022, in vacancies in the manufacturing sector, which includes chemicals.[21] It also showed historic lows in employer investment, with per employee spending on training decreasing by 19 per cent in real terms over the same period.[22] A shortage of STEM skills, alongside poor 'on the job' skills investment, suggests the problem needs addressing both directly within the industry and further upstream in education.

The documented shortage of STEM skills in the UK, compounded by pervasive negative perceptions of plastics, fossil fuels and, by extension, the chemical industry, were frequently highlighted as significant recruitment challenges during our interviews. A disconnect was also noted between experience developed in university-based education and the industry skills required.

We suggest apprenticeships as a solution to partly address this, for which a good framework already exists, although there are some barriers to uptake.

Interviewees highlighted that the lower level apprenticeships, especially in manufacturing, were not receiving adequate funding, leaving local providers struggling to enrol enough students to cover costs and recruit skilled teachers. At the higher apprenticeship levels, universities need support in adhering to Ofsted regulations to increase the supply of courses.

Skills: how to overcome barriers

Barriers	Solutions
➢ STEM skills shortage ➢ Green skills shortage ➢ Poor on the job training opportunities ➢ Inadequate funding and implementation of apprenticeships	➢ Enhance industry investment in training and the sector's image ➢ Increase funding for lower level apprenticeships ➢ Support universities to adhere to higher level apprenticeship regulation

The role of carbon pricing

Carbon pricing was not a significant focus of our interviews or research, but carbon leakage is a significant risk to transitioning industries, especially those with global markets like the chemical industry. Although most chemical manufacturing sites are covered by the UK ETS, most chemical products are not expected to be part of the initial implementation of the UK's carbon border adjustment mechanism (CBAM). Only fertilisers are proposed to be covered by the CBAM.

A functioning ETS and CBAM would address some of the cost challenges in many of the policy areas explored above. Industry voices in the EU have called for the staggered inclusion of entire chemical value chains in a CBAM.[23] To do this, carbon pricing policy must overcome its aversion to including complex industries like the chemical industry. Even then, a CBAM may not protect exported products from competition by dirtier producers, but exports to the EU could at least be covered by an expanded EU CBAM.

Conclusion

Our analysis sheds light on the significant challenges facing the UK chemical industry as it moves towards a greener, more sustainable future. We have considered six critical areas necessary for this transition and, by combining our own research with stakeholder insights, we have identified a range of areas for policy improvement.

While there is notable government support for carbon capture and storage and hydrogen fuel switching, we stress that more diverse strategies are needed, including electrification, resource efficiency and alternative feedstock development. Addressing the significant skills gaps and the innovation 'valley of death' will also be needed to facilitate the industry's green transition.

Despite existing policy shortcomings, as we have shown, there are plenty of opportunities that the government could take advantage of to reduce the industry's climate impact and enhance the sector's competitiveness. As well as supportive government measures, there may also be a need for tighter regulation to prevent parts of the industry falling behind or delays to overall progress. A balance between 'sticks' and 'carrots' is needed to ensure a level playing field for the industry to invest and be part of a greener future.

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Endnotes

[1] Interviewees were representatives from industry, trade and professional associations, academics and civil servants.
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