

Carbon Capture and Storage – “A necessity, not an option”



A background paper for The Infrastructure Forum on the need for the widespread introduction of CCS in the UK

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Why is major investment in Carbon Capture and Storage (CCS) recommended by the Intergovernmental Panel on Climate Change (IPCC) and the UK's Committee on Climate Change (CCC) as "a necessity, not an option"? This paper summarises the need for CCS investment as an important part of the UK achieving 'Net Zero' by 2050.

Why the need for CCS?

The UK's investment in renewables has shown world leadership in looking to reduce our country's carbon emissions. However, a commitment to Net Zero by 2050 is a game changer; it shows the limitations of renewables and by implication the critical supplementary role CCS can play to achieve this goal, for four key reasons:

Energy intensity; electricity is only part of the solution - the scale and intensity of UK energy usage for industry, heating, and transport, creating almost 2/3 of our CO₂ emissions, has been relatively untouched by the rise of renewables. The scale of power needed probably exceeds the potential capacity of renewables, even assuming it were acceptable to so significantly increase our land and sea dedication to wind and solar. The intensity needed means that industry needs power and heat in large amounts. A switch to hydrogen produced by CCS will offer an energy-intense alternative.

Reaching those parts others can't reach - in many industries electricity cannot substitute fossil fuels or address the problem. For instance, much of heavy industry produces CO₂ as part of its processes; around 65% of cement production and 30-40% of petrochemical emissions derive from their inherent processes, not their power consumption. Similarly, the intensity of others such as steel production and Heavy Goods Vehicles (HGVs) require high levels of energy, difficult to achieve using electricity. These businesses can only continue to exist in a world of Net Zero if we can store the CO₂ they produce and replace oil and methane with hydrogen as their primary source of power.

Dealing with intermittency - wind and solar are intermittent on a seasonal, daily and minute-by-minute basis. A reliable electricity supply will require the flexible CO₂-free generation that CCS delivers.

Negative emissions - by storing CO₂ that has been taken from the atmosphere, either by new Direct Air Capture technologies but principally from bio-energy with CCS ("BECCS") (using wood that has captured CO₂ from the atmosphere as the fuel source for power), CCS can offset CO₂

emissions from sectors failing to decarbonise fast enough; the aviation sector might be an obvious example.

For these principal reasons, the CCC's CCS scenarios envisage aggregate annual capture and storage of 75-175 mt CO₂ by 2050, 3-6 times the current industrial emissions from our main Industrial Clusters, all of which will need CCS to decarbonise. This will require a major Transport and Storage infrastructure, servicing the UK's main clusters, with some CO₂ also transported by ships and road.

This is an ambitious target, but without it we won't achieve Net Zero.

The industrial clusters - decarbonising and expanding

The UK's industrial emissions are centred around 6 major Industrial Clusters that together emit over 30 Mtons CO₂ per annum in industrial emissions. To meet the CCC targets of 75-175 mt CO₂ annual storage will require not only full decarbonisation of existing industry at those clusters, but also a ramp up of new CCS production of hydrogen, use of bio-energy and post combustion CCS power.



Figure 1: The largest UK clusters by industrial emissions only

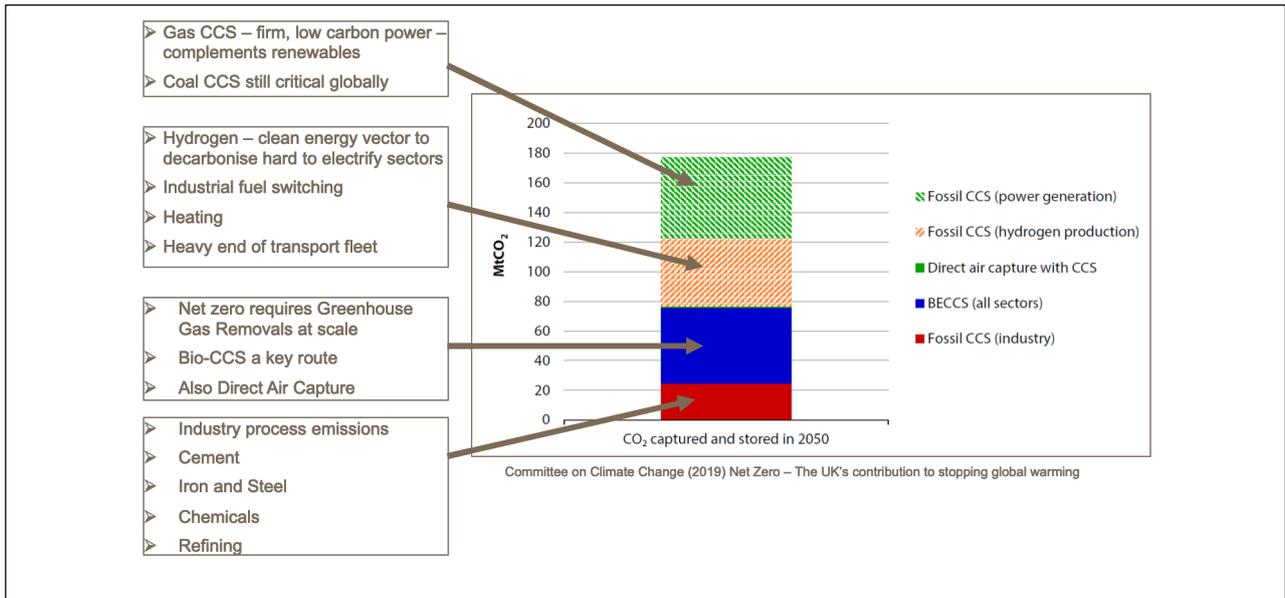


Figure 2: The CCC's forecast of how CCS could store 175 Mtons CO₂ per annum by 2050

The leading UK Industrial Clusters have been investing heavily in developing integrated plans for cluster decarbonisation and new CCS power, hydrogen and BECCS, including key anchor projects and a suite of follow-on projects.

Five cluster plans have been developed in the key industrial regions of Scotland, Teesside, Humberside, the North West and South Wales. To implement the plans at all 5 clusters together will need the creation of 3 CO₂ storage regions along the East and West coasts of the UK, which with pipes and shipping can link to all five clusters, as well as the Southampton cluster and converted power plants for London at the Isle of Grain.

These Industrial Clusters are currently applying to Government for matched grant to fund the Front-End Engineering and Design (FEED) of the first wave of projects and the related storage regions. BEIS, with industry input, are also developing the business models needed at the end of FEED to progress the implementation of the projects.

The breadth of decarbonisation opportunities

The leading projects within clusters address decarbonisation in several sectors of the economy by both fuel substitution by hydrogen and by direct capture of emissions on site. The projects include:

- integrated transmission and storage of CO₂
- direct capture from a range of industrial installations
- the production of hydrogen by reforming methane into hydrogen and CO₂
- fuel substitution by hydrogen in industry
- fuel substitution by hydrogen for power generation
- injection of hydrogen into the gas distribution and gas transmission networks
- direct capture from CCGT power generation
- direct capture from biomass power generation (BECCS), creating negative emissions
- the creation of hydrogen distribution infrastructure which increases the geographical reach of bulk hydrogen with CCS

While some projects build on existing oil and gas infrastructure (the North West and Scottish projects), others involve the creation of a new CO₂ store and pipelines (Teesside and Humber) or CO₂ shipping (South Wales).

Investing at scale

If investment in CCS is made at scale across the UK, the **CCS Advisory Group (CAG)** (a public-private industry body formed in 2019 to push forward the development of the underlying business models and address industry-wide issues) described how it will deliver:

- **New clean products** - UK industry can build new markets based on the growing demand for low carbon products and technologies. The UK could become a centre for low carbon production and a global exporter
- **Inward investment into UK industrial regions in the north of England, Scotland and Wales, and opportunities for exports from the UK of low carbon products globally** - positioning UK clusters as leading areas for global inward investment in clean technologies
- **Job creation and retention** - through investing in clean growth, developing competitive advantage, protecting existing industries in the regions and avoiding higher carbon off-shoring, plus fostering regional growth in what can become zero emission industrial heartlands
- **A cost-competitive industry** - CCS is essential to delivering Net Zero for the UK in the most cost competitive way possible. Even just targeting an 80% reduction in CO₂, the Energy Technologies Institute (ETI) has already

calculated that CCS significantly reduces the cost of decarbonisation, by more than £35 billion per year

- **A cross-economy reach** - enables decarbonisation of many parts of the economy including activities that other technologies can't decarbonise, including parts of domestic and industrial heat, transport, and industries like cement that produce CO₂ in the manufacturing process
- **A just transition for people and places**- a smooth and rapid transition to a clean UK industry, ensuring industry remains competitive globally, protecting jobs across the regions and ensuring a best value, low carbon transition for consumers
- **UK leadership** - leading the world in a transition to Net Zero; a green industrial revolution, where bold UK action ahead of COP26 will encourage other countries to act and follow
- **A revenue generator** - creates income from other countries to store their CO₂; by leading the world, the UK can become the natural store for other countries' CO₂, reducing the net cost of implementing CCS to the UK alone.
- **Reliable technology** - implementing a safe, reliable, and proven technology; helping air quality in the UK industrial Clusters, not just reducing CO₂ emissions
- **The enabling of a hydrogen economy** - creating the infrastructure which will benefit all new green sources of hydrogen
- **Growth built on our advantages** - we have the geology, skills, the ability to re-use oil and gas assets, a developed finance sector, and track record in decarbonisation to lead the world
- **Low risk investment** - it is based on technologies that have been safely and reliably used for decades in the oil and gas and petrochemical industries
- **Negative emissions** - technologies such as Bio Energy with CCS (BECCS) are the key way to provide the negative emissions needed to reach the Net Zero target; offsetting sectors of the economy difficult to decarbonise such as flights. Developing the BECCS sector fast significantly increases the probability and lowers the cost of achieving Net Zero

- **Scale of impact** – the decarbonisation challenge is huge. CCS is a technology that can deliver at a scale that makes a significant contribution to carbon budgets
- **Policy Options** – CCS unlocks several pathways to reach Net Zero and a technology that can be ramped up if other parts of the economy fail to decarbonise. Creating CCS at the clusters is a low regrets decision that delivers policy options
- **Huge growth potential** – if we invest ambitiously now, clusters collectively have the opportunity to deliver within or exceed the higher ranges of the Committee on Climate Change’s 175MTCO₂pa target – CCS can therefore remedy any shortfall from other technologies and/or allow faster decarbonisation of the economy

What if we don’t invest in CCS Now?

In contrast, without scale investment in CCS now, the CCS Advisory Group concluded the UK will lose economically and risks failing to deliver Net Zero, in particular:

- The UK will lose industrial competitiveness and the opportunity to lead the world both in our promotion of an essential industry and through our moral leadership
- At a considerable cost to the UK taxpayer, all our oil and gas assets will be scrapped rather than some being repurposed
- The UK will NOT be able to decarbonise swathes of industry (those that emit CO₂ as part of their manufacturing process) and thus these jobs and GDP contributions will be lost
- The consequential “Offshoring” of our CO₂ manufacturing emissions actually increases global climate change emissions- as the UK has higher efficiencies in manufacturing
- The UK will lose a multi-billion-pound potential revenue stream for storing CO₂ from other countries who do not deploy CCS and could end up paying other countries billions per year to store our CO₂

Conclusion

In summary, CCS is essential technology for delivering Net Zero. CCS can deliver low carbon power, industrial decarbonisation, the energy intensity, negative emissions and a transformation to a hydrogen economy, that will all be required to transition to a carbon free economy.

The key question is therefore not whether, but how fast, the UK should invest in and transition to CCS.

The strategic case for substantial investment is considered further in an associated paper; **"CCS - time for an ambitious leap forward"**.

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About the author:



For the past 4 years, Paul has been an independent infrastructure adviser, after over a decade in project finance banking and then 20 years as an infrastructure partner at PricewaterhouseCoopers.

He established and chaired the CCS Advisory Group and is now adviser to BEIS on the implementation of CCUS in the UK and a member of the Committee on Climate Change's industry decarbonisation policy steering group.

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