Friends of the Earth Scotland and Global Witness
Briefing: Tyndall Centre, "*A Review of the Role of Fossil Fuel-Based Carbon Capture and Storage in the Energy System*"

Summary
Climate researchers have carried out a comprehensive analysis of the role of fossil fuel-based Carbon Capture and Storage (CCS) in the energy system, and its ability to help to achieve the Paris Agreement goal of limiting global average temperature increases to 1.5°C.

Current status of fossil fuel-based CCS in the energy system

- The scale of deployment of CCS to date is significantly less than proponents have predicted with only 26 CCS plants currently in operation globally.
- Global operational CCS capacity is currently 39MtCO_2 per year, this is about 0.1% of annual global emissions from fossil fuels and less than Scotland's territorial emissions in 2018, and there is no operational CCS capacity in the UK at all.
- 81% of carbon captured to date has been used to extract more oil via the process of Enhanced Oil Recovery (EOR). This means CCS is being predominantly used for carbon emitting oil extraction that wouldn't have otherwise been possible.
- Current CCS projects usually target 90% capture at peak capacity. The Petra Nova facility missed capture targets by around 17% since starting in 2017.
- During the initial deployment of CCS in the power sector, capture rates are often around 65%, gradually building to 90% capture only after several years of operations.

Key implications for delivering Paris Agreement goal to limit warming to 1.5°C

- Fossil fuel-based CCS is not capable of operating with zero emissions. Many projections assume a capture rate for CCS of 95%, however, capture rates at that level are unproven in practice.
- Fossil fuel-based CCS will continue to entail residual, process and supply chain greenhouse gas emissions. There must be consideration of whether fossil fuel hydrogen with CCS is sufficiently low-carbon relative to remaining carbon budgets.
- Even if the technology is to become economically and technically viable at scale, optimistic forecasts do not anticipate significant CCS capacity until at least the 2030s.
- A focus on CCS will not help achieve 2030 CO_2 emission reduction targets. The research emphasises the real danger of reliance on CCS in energy for delivering these vital emission reductions given they cannot be expected until at least 2030.

On the basis of this research, Friends of the Earth Scotland and Global Witness believe the promotion of CCS in energy is a distraction from the rapid growth of renewable energy and energy efficiency required. We urge instead reliance on technologies that can deliver the emissions reductions required by 2030 if we are to deliver on the Paris Agreement goals.

Overview

A new study by researchers from the Tyndall Centre, the world-renowned centre of climate change research, commissioned by Friends of the Earth Scotland and Global Witness, sheds new light on Carbon Capture and Storage (CCS). The research reveals the huge gap between the previous projections for CCS, the current capacity and expectations in future energy pathways. It concludes that fossil fuel-based CCS will not be deployed significantly until at least the 2030s with numerous barriers to short-term deployment.

CCS is a technology that has been proposed as a means of reducing carbon emissions for over four decades. The process involves separating and capturing carbon dioxide from other gases before it enters the atmosphere, converting the gas into a liquid form for transport by pipeline or tanker. The carbon dioxide is then to be pumped deep underground with monitoring essential to ensure long-term storage.[1] While it is considered theoretically possible for the technology to capture over 95% of carbon, the increased energy use and cost penalties in doing this means current projects usually target 90% capture at peak capacity. The Petra Nova facility which started in 2017 has suffered outages on 367 days and missed capture targets by around 17%.[2]

Countries and regions around the world, including the Scottish Government, have committed to higher emissions reductions targets for 2030, in light of the Paris Agreement goal to try to limit warming to 1.5°C. When outlining their proposals to deliver on these new targets, governments are predicting a significant role for CCS. Therefore, this is a crucial time to examine the projected reliance on CCS technology in the energy sector, including the proposed production of fossil fuel hydrogen, and whether it can be relied upon to deliver these 2030 emission reduction targets.

Huge gap between current capacity and projections as CCS under delivers

The technical feasibility of CCS was demonstrated in 1996, however, deployment has been slow and sites under development have consistently failed to materialise. According to the Global CCS Institute, less than a fifth of CCS capacity under development in 2010 was operational by 2019. Despite this, CCS features prominently in many future energy pathways with a stark contrast between projections and the current capacity globally of just 39MtCO_2 a year across 26 plants.

For example, the report shows that current capacity in the energy sector is just 2.4 MtCO_2 a year. This compares to the International Energy Agency's (IEA) estimate of 310 MtCO_2 a year in the energy sector by 2030, an increase of 129 times from today. Despite two CCS competitions for £1bn in funding, there are no operational CCS plants in the UK. The UK Committee on Climate Change projects a capacity of between 75 - 175 MtCO_2 a year by 2050. The higher estimate would mean deployment in the UK alone of over quadruple the entire global capacity today.

The research concludes that *"the current trend of CCS deployment worldwide has yet to reach the pace of development necessary for these scenarios [of CCS deployment] to be realised."* In terms of projects in development, it also notes *"inconsistency between CCS projects...and interim and long-term expectations*". While CCS has repeatedly failed to deliver at scale, the report comments

[1] LSE, *What is carbon capture and storage and what role can it play in tackling climate change?*
[2] Nichola Groom, Reuters, *Problems plagued US CO2 Capture Project Before Shutdown,* August 2020

on faster than expected progress on renewables, energy storage and demand-side technologies.

Friends of the Earth Scotland and Global Witness believe that 2030 emissions reduction targets are being set up to fail due to the huge emphasis placed on CCS. The technology has a track record of under-delivering and is already not expected significantly until at least the 2030s.

Costly CCS not expected in the UK significantly until at least 2030

The research outlines barriers and challenges for fossil fuel-based CCS to deliver emissions reductions over the next decade, including the costs, timescales and residual emissions.

Firstly, the costs involved are prohibitive, with CCS often required to be built onto existing infrastructure. The Boundary Dam coal-fired power plant in Canada had capital costs of approximately US$455 million and a capture cost of US$100 per tonne of CO_2. The site started operation in 2014 and has captured a cumulative 3.4MtCO_2 up to July 2020. We calculate that this represents an average annual capture rate of just 560ktCO_2 at a cost of US$56m. For comparison, Scotland's Longannet coal-fired power station released 9.5MtCO_2 in 2013 - 17 times as much.[3]

The research reveals that to date, 81% of carbon captured has been used for Enhanced Oil Recovery (EOR). This process sees captured carbon pumped underground to push previously unreachable fossil fuels up for extraction, extending the life of oil fields. This means that the financing of these CCS projects has relied on the increased revenue from EOR, demonstrated by the mothballing of the Petra Nova's CCS site since the fall in oil prices in 2020.[4] Carbon capture for EOR continues to dominate planned projects, despite a projected minor role in 2030 pathways. The commitment of the oil and gas industry to deliver the scale of CCS projected for mitigation is in serious doubt, particularly in light of the significant capital and ongoing costs of CCS.

There is also significant deployment time to consider with a period of 6-10 years assumed in some analysis for prospective UK projects.[5] Deployment has also been far slower than predicted, with sites in development in 2010 with a potential capacity of 150Mt a year ultimately resulting in just 39Mt by 2020 - highlighting the major barriers to deployment at any scale.

Even if CCS for mitigation can be proven economically and technically viable at scale, there will continue to be carbon dioxide, as well as methane emissions, from CCS fossil fuel energy that cannot be captured. This is the case for both fossil fuel hydrogen and gas power stations fitted with CCS. Current projects usually target 90% capture at peak capacity. Since beginning in 2017, the Petra Nova facility has missed capture targets by around 17%.[6] Moreover, in the case of fossil fuel hydrogen, the research states that given the process and supply emissions involved, "*whether fossil fuel-based hydrogen is sufficiently low carbon...to have a major role in energy provision is an important consideration"* in the context of remaining carbon budgets.

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[3] Scottish Environment Protection Agency, *Scottish pollutant release inventory*
[4] Nichola Groom, Reuters, *Problems plagued US CO2 Capture Project Before Shutdown,* August 2020
[5] UKCCC, *A Strategic Approach to Developing Carbon Capture and Storage in the UK,* June 2016
[6] Nichola Groom, Reuters, *Problems plagued US CO2 Capture Project Before Shutdown,* August 2020

Significant fossil fuel CCS in the UK is now not expected until 2030, with a huge gap between the emphasis placed on CCS in reducing emissions and the need for rapid reductions over the crucial next decade. Against a backdrop of failure over many years, the question of costs remains unresolved and there are residual, process and supply chain emissions which must be considered. With higher targets for emissions reductions by 2030 in Scotland, the UK and the EU, there is an urgent need to prioritise renewables, storage and demand-side policies.

Reliance on CCS is not a solution to the climate emergency

The fossil fuel industry has been pushing for CCS, and hydrogen made from fossil gas, to be a big part of proposals for delivering on the Paris Agreement goals. However, this research shows that we cannot rely on fossil fuel CCS to deliver significantly in the next decade. The technology still faces many barriers, would only start to deliver too late, would have to be deployed on a massive scale at a scarcely credible rate and has a history of over-promising and under-delivering.

The Scottish Government is committed to emissions reductions of 75% on 1990 baseline levels by 2030 and to pursue efforts to limit warming to 1.5ºC under the Paris Agreement. The IPCC Special Report in 2018 described the next decade as vital to limit warming to 1.5ºC with “transformative, far-reaching” change required in every sector to deliver the necessary emissions reductions.

It is the cumulative emissions from each year between now and 2030 that will determine whether we are to achieve the Paris 1.5°C goal. With carbon budgets increasingly constrained, the report shows that we cannot expect CCS to make a meaningful contribution to 2030 climate targets. In this context, fossil fuel CCS is a distraction from the growth of renewable energy, storage and energy efficiency that will be critical to rapidly reduce emissions over the next decade.

The Scottish Government is about to make crucial decisions that will lock in emissions reduction plans for the next decade, particularly through the Climate Change Plan and the Energy Strategy.

Friends of the Earth Scotland and Global Witness recommend focus on technologies that can meaningfully reduce emissions over the next decade to deliver on the Paris Agreement goal to limit warming to 1.5ºC. Instead of fossil-fuel CCS, there is a need to rapidly increase renewable energy generation and tackle energy efficiency. Almost immediately, these can produce larger and more rapid carbon reductions in this vital decade, create more jobs and improve people’s homes.

The full report is here: https://foe.scot/resource/report-carbon-capture-storage-energy-role

This briefing is written by Friends of the Earth Scotland and Global Witness based on peer-reviewed research commissioned from the Tyndall Centre for Climate Change Research. All views contained within the Tyndall Centre report are attributable solely to the authors and do not necessarily reflect those of researchers within the wider Tyndall Centre.

Friends of the Earth Scotland campaigns for socially just solutions to environmental problems and to create a green economy; for a world where everyone can enjoy a healthy environment and a fair share of the earth’s resources.

Global Witness is an international organisation with offices in London, Washington DC and Brussels. Our goal is a more sustainable, just and equal planet. We want climate-critical forests and biodiversity to thrive and fossil fuels to stay in the ground. We want corporations to respect the planet and human rights, governments to protect and listen to their citizens, and the online world to be free from misinformation and hate.