Update on Carbon Capture and Storage (Quarterly #4, Part 1)

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CARBON CAPTURE AND STORAGE (CCS) IN THE NORTH SEA REGION

Some coastal member states of the North Sea, e.g., Norway and Great Britain, propose to use the North Sea as a storage site for CO_2. Some projects want to install new structures such as pipelines for this purpose, while a Scottish project aims to use already existing structures. The projects are developed around industries which are energy intensive and dependent on fossil fuels. Many project participants extract fossil fuels themselves and aim to inject CO_2 below the North Sea, e.g., in empty gas reservoirs.

Researchers at the Geomar Helmholtz Centre for Ocean Research in Kiel, Germany, have taken a closer look at the North Sea's oil and gas wells and published their results in September 2020. Their study area covered 20,000 km² and contains 1,792 documented wells. The study found that abandoned oil and gas wells leak considerable amounts of the potent greenhouse gas methane. Most of the gas originates from shallow gas pockets, less than 1 km below the seafloor. If degraded microbially, methane can contribute to seawater acidification. In the North Sea, about half of the wells are located in shallow water, so that a part of the methane leaking from the seafloor reaches the atmosphere, thus contributing to global warming.

Methane leakage has been detected at 65 % of the directly investigated wells. The researchers estimate that wells in the study area (20,000 km²) emit 900 to 3,700 tons of methane annually. However, the North Sea covers an area of 570,000 km² and in the entire North Sea, more than 20,500 hydrocarbon wells for oil and gas production have been documented. The authors of the study recommend independent emission measurements as well as stricter and legally binding regulations for methane emissions from abandoned boreholes.[1]

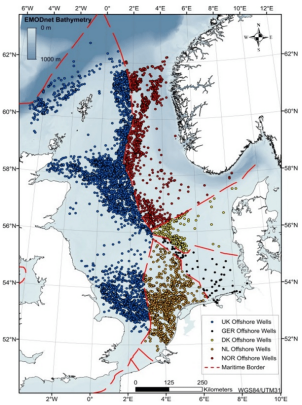

Figure 1: *Distribution of drill holes in the North Sea. The North Sea comprises of 20,507 documented offshore wells. No new oil and gas exploration wells will be drilled in the Danish sector.* (Copyright: Christoph Böttner, Geomar Helmholtz Centre for Ocean Research in Kiel, https://www.geomar.de/en/news/article/neue-studie-bestaetigt-umfangreiche-gasleckagen-in-der-nordsee)

In an interview, the head of the Geomar study points out that methane leakage is not unique to the underwater environment and estimates that the situation on-shore is similar in many areas, because geology is comparable. He adds, that on-shore leaks are not quite easy to find as the bubbling plumes of gas underwater.[2] The problem of methane leakage exists worldwide and wells are not always well documented, e.g., the number of abandoned wells in the US federal state Pennsylvania is estimated at 470,000–750,000.[3]

The number of (documented) wells and the reports of methane leaks do not inspire much confidence: The same industry that allows methane to escape from abandoned wells is now supposed to use large amounts of taxpayers' money to ensure that another climate-relevant gas is stored underground? That's exactly what Carbon Capture and Storage (CCS) is aiming to do: captured CO_2, emitted by fossil fuel burning power plants or other industrial sources, is liquified and then pumped underground – theoretically for long-term storage. If not even all hydrocarbon wells are known – how can it be guaranteed that the injected CO_2 will not leak back into the atmosphere? Earthquakes and other underground movements cannot be ruled out as causes of leakage either.[4]

Although burning of fossil fuels is the leading direct cause of the climate crisis, governments continue to subsidize the fossil fuel industry. The direct and indirect subsidies are estimated at 6.5 % of the global gross domestic product – more than twice the total worldwide investments in all types of research and development.[5] In October 2020, researchers at Cambridge University, Great Britain, called for an end to all government subsidies to the fossil industry, to ban all explorations for new oil, gas and coal reserves, and to proceed on the premise that so-called "negative emission technologies", such as CCS or BECCS, will not work at scale.[6] Another study, also published in October 2020, draws the conclusion that "*large-scale deployment of CCS could double the water footprint of humanity*" and "*exacerbate and create green and blue water scarcity conditions in many regions worldwide*".[7]

Danish policymakers arrived at similar assessments and put an end to the fossil area: In December 2020, Denmark decided to immediately end all North Sea oil and gas exploration, and to phase out fossil fuel extraction by 2050.[8]

At the same time, the European Union's Research Fund for Coal and Steel (RFCS) sees CCS as a way to prolong the survival of fossil fuels. The RFCS funds the research project **'Establishing a Research Observatory to unlock European Coal seams for Carbon dioxide Storage' (ROCCS)**. The project is coordinated by Cardiff University, Great Britain, and conducted in cooperation with research institutions in Europe. ROCCS aims "*to develop best practice guidelines for commercial scale CO_2 injection and storage in coal*" in order to meet the following RFCS research priority: "*Improving the competitive position of European Union coal*". The project includes demonstration tests at the coal mine 'Barbara' in southern Poland and plans to inject one to ten tons of CO_2 into the coal seam.[9]

In the Netherlands, the **Porthos CCS project** aims to capture CO_2 in Rotterdam's port area and transport it via a 21 km pipeline for storage in empty natural gas fields off the coast in the North Sea. Porthos stands for "Port Of Rotterdam CO_2 Transport Hub & Offshore Storage" and is a joint project of the Port of Rotterdam, EBN and Gasunie. In November 2020, Porthos renewed its agreement with Air Liquide, Air Products, ExxonMobil and Shell. After that, the joint development partners applied for the SDE++ grant, the Dutch national grant programme for carbon reduction initiatives. A final investment decision for Porthos is expected over the course of 2021. Construction of Porthos infrastructure is scheduled for 2022/2023. The project plans to start CO_2 injections by 2024. Porthos aims

to store 2,5 million tons of CO_2 annually for a term of 15 years. The CO_2 will be injected into a sandstone formation off the coast, at 3 km depth. In 2019, Porthos announced plans to construct cross-border pipelines to ports in Belgium and Luxembourg region (Antwerp, Ghent) and an expansion of the annual storage volume to 10 Mt of CO_2 – it seems these plans have been dropped. In October 2020, the European Commission has proposed awarding € 102 million in funding to the Porthos project. The expected total costs amount to € 450 to € 500 million. Despite this impressive amount, Porthos will only be able to capture and inject 10 % of the emissions produced by Rotterdam's industrial sector.[10]

The Port of Rotterdam has seen two earlier CCS initiatives. Both, the **Rotterdam CCS Demonstration Project – ROAD (former Maasvlakte Project)** and the **Rotterdam Climate Initiative (RCI)** planned to capture CO_2 from industrial sources within the port area and to carry it to an offshore storage location. ROAD was cancelled in 2017; RCI's website went offline in 2018. Both projects received public and private funding, e.g., ROAD has cost taxpayers € 330 million.[11]

In Great Britain, the **Acorn CCS Project**, centred on the St Fergus Gas Plant north of Aberdeen in northeast Scotland, has won £ 62 million in public funding, in order to initiate large-scale hydrogen production in combination with CCS by 2025. The engineering firm Petrofac has won the contract to support the FEED for a 200 MW hydrogen reformer (a plant reforming natural gas to hydrogen). The Acorn project is led by Pale Blue Dot Energy Ltd. and aims to deliver a low-cost CCS in northeast Scotland by 2023, capturing CO_2 from the St. Fergus gas processing plant as well as additional CO_2 from industrial emitters around Grangemouth, and transporting the captured CO_2 for storage beneath the North Sea to depleted gas fields. Instead of creating new structures, the project suggests using existing offshore infrastructure which is potentially re-usable for CCS: Pipelines, which would be decommissioned as gas fields run out, e.g., the Goldeneye and the Miller Gas System pipeline, could be repurposed to take CO_2 in the opposite direction. The project is supported by companies such as RWE, Shell, Petroineos and Total. Further public funding may be granted by the British government – the governmental Spending Review 2020 was updated in December 2020 and increased the funding for a CCS Infrastructure Fund to £ 1 billion.[12]

An earlier Scottish CCS project, the **Logannet Project**, has also proposed CO_2 storage in depleted gas fields in the North Sea, via Shell's Goldeneye platform. The project was cancelled in 2011, because the UK Department of Energy and Climate Change withdrew its funding commitment, not being convinced of the project's commercial viability.[13]

In December 2020, the UK Climate Assembly published its report "The path to net zero". Only 22 % of the climate assembly members support the use of fossil fuels with CCS, while 95 % support offshore wind. Nature-based greenhouse gas removal methods, such as improved management of forest and wetland, were backed with 85 % to 99 %. Many assembly members worried about the risk of leaks from CCS sites.[14]

In December 2020, the Norwegian parliament approved € 1.6 billion in funding for the **Longship CCS Project**. The projects former name – **Northern Lights Project** – has been replaced and is now only used for the transport and storage part of the Longship CCS project. Longship aims to capture CO_2 at Norcem's Cement factory in Brevik, and at Fortum's Recycling plant in Oslo. The captured CO_2 will be liquefied and transported by (fossil-fueled) ships, over 700 km, from Oslo area to a hub near Equinor's Kollsnes plant. From Kollsnes the CO_2 will be sent offshore by a 110 km pipeline and injected into a depleted well in the Johansen formation, ~30 km offshore mainland Norway. The permit to exploit an area for CO_2 injection and storage was granted in 2019 and a first exploration well has been drilled. The total project costs are estimated at € 2.38 billion – this includes € 0.76 billion in operating costs until the tenth year of operation.[15] Each, the Fortum and the Norcem plant plan to capture 0.4 million tons of CO_2 annually at full scale. Over a project period of 10 years, the costs to capture and store 1 ton of CO_2 amount to € 297,5 per ton, almost entirely paid by taxpayers' money[16], but without certainty that the CO_2 is really stored safely.[17]

ENDNOTES

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