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New and old CCS projects in Europe: What's different this time?

In Europe, several new CCS (Carbon Capture and Storage) projects aim to address clusters of industrial emissions, decarbonise hydrogen production and transport of CO_2 for storage across borders. They will take place in hubs and clusters where different industries may share transport and storage infrastructure allowing for a cross-sectorial and cross-border industrial system. Coupled with hydrogen infrastructure, CCS can also deliver low-carbon hydrogen across sectors of the European economy. CCS failed to live up to its potential during the previous investment cycle (2009-2015). However, in comparison to previous waves of projects, the design and focus of new projects as well as the policy environment has changed, making the case for CCS as a key component in reaching the EUs climate objectives.

What's different this time?

- **Innovation in CCS business models** has shifted the focus away from single emission sources on to industrial clusters linked with CCS hubs, allowing for a better spread of risk and investment across the value chain and achieving economies of scale.
- **Improved design of EU funding instruments**, such as the Innovation Fund, may now help supporting CCS projects through improved risk-sharing, simple selection processes, stronger synergies between different programmes and streamlined governance and decision-making processes.
- **Low-carbon hydrogen production with CCS** allows for extending the climate benefits of CCS beyond the power sector, as hydrogen can support the decarbonisation of EU industrial, transport, power and heating sectors while revenues may underpin and finance the integrated CCS component.
- **Finally, a higher CO_2 ETS price will no doubt favour the economics of investments in new projects**

1) Innovation in CCS business models: Single industrial emitter vs. hub and cluster-based projects

The business model of CCS projects promoted in 2009-2015 was considerably different in comparison with that of projects promoted today. In earlier development phases, CCS projects were linked to **a single industrial emitter**, whereas today we see the development of **CCS hubs linked with industrial clusters** where emissions are captured from different installations which can benefit from a shared infrastructure.

Under this approach, risks, investments and support mechanisms can be better spread across the CCS value chain, as industrial installations, gas infrastructure companies, upstream E&P companies, and/or new state owned or regulated storage entities can have clear and coordinated roles for delivering and being compensated for capture, transport and storage activities. The shared approach to the transport and storage infrastructure also creates economies of scale, driving down unit costs for the CCS value chain.

Examples of hub and cluster-based CCS projects

The Rotterdam CCUS project Porthos[1]

The Rotterdam CCUS project Porthos (Gasunie, EBN, & Port of Rotterdam Authority) aims at collecting the CO_2 from multiple industrial installations in the Rotterdam port area and transport it in **an open-access, public pipeline for offshore storage** to a depleted gas field 25km from the coast at a depth of around 3 km. Under the plan, around 2.5 – 5 Mtpa CO_2 from the **refineries and chemical plants in the port** would be captured and stored. A relatively small amount of CO_2 from Rotterdam industry is already being used (CCU) by greenhouse horticulture in South Holland, where it enables plants to grow faster. The Porthos infrastructure will also be suitable for transporting CO_2 for use by industry, if there is demand for this in the future.

In February 2019, companies were invited to participate to an 'Expression of Interest', to signal their potential readiness to supply volumes of CO_2 into the planned public collector pipeline. As of December 2019, Porthos has signed an agreement with companies ExxonMobil, Shell, Air Liquide and Air Products to work on preparations for the capture, transport and storage of CO_2. The capture is to take place at the companies' refineries and hydrogen production sites in Rotterdam. Transport to and storage beneath the North Sea is being prepared by Porthos. Sharing a common infrastructure between several industrial sites, the Porthos project aims to **drive cost efficiencies** relative to old CCS business models based on a single industrial emitter. The project was awarded CEF funding in January 2019 and has enjoyed the status of Project of Common Interest (PCI) since 2017.

Finally, the Dutch government, has put in place a financing scheme SDE+ which is a kind of contract for differences between the current ETS Price and the needed CO_2 price to make the project economically viable.

Northern Lights and The Norwegian full-scale CCS project

The Northern Lights project is designed to constitute **a ship-based open source European CO_2 transport and storage network**. By recovering CO_2 emissions from European industries, the project is looking to achieve economies of scale and lower costs, while also making a larger-scale contribution reducing EU CO_2 emissions. Due to its pan-European approach, the project will facilitate the establishment of horizontal industry-wide standards to promote the interoperability of the CO_2 ships and storage sites with EU Member States. The ship-based solution makes CCS relevant for many companies and industrial sites, as they now can connect to a CO_2 storage solution. Northern Lights has identified 350 industrial sites with CO_2 emissions of more than 100 ktpa that are within reach of its ships, and have signed MoUs with 7 of them in 6 European countries.

The CO_2 shipping component of this project first received PCI status in 2017. In 2020, the project was granted an updated PCI status, expanding its geographical scope to capture sites located in Belgium, France, Germany, Ireland, the Netherlands, Sweden and the UK. Equinor, Total and Shell are responsible for the transport and storage parts of the project. The partners are currently conducting FEED studies and aim at final investment decisions in 2020. The Northern Lights CO_2 transport and storage project is then planned to start operating in 2024, and the project's extension to cross-border shipping of CO_2 is expected to take place from 2024-25.

The Norwegian full-scale CCS project, of which Northern Lights is the transport and storage part, aims to become the world´s first CCS project receiving CO_2 from **several industrial sources.** The concept of the Norwegian full-scale CCS project foresees CO_2 capture in two onshore industrial facilities for transport by ship to a receiving point in Naturgassparken in Øygarden municipality, where it will be sent through pipelines to offshore injection wells on the Norwegian Continental Shelf.

1 Rotterdam CCUS project Porthos information: https://www.rotterdamccus.nl/en/

2) Well-designed EU funding instruments

EU funding instruments have been revised to better support innovative, large-scale decarbonisation projects. In 2018, the European Court of Auditors published a special report where the lack of success in reaching the ambitious goals of the NER300, a funding instrument established in 2009 based on ETS allowances, was subject to an audit. It emerged that at the time of the NER300, a **lack of certainty around policies, regulations and public financial support** affected the financial viability and progress of innovative low-carbon energy demonstration projects. Moreover, the low price of the ETS negatively impacted the firepower of the NER300, bringing the expected largest possible size of a grant from €675 million to €337 million, thus representing a major setback for capital-intensive CCS projects that required greater support.

The design of NER300 limited the Commission and Member States' ability to respond to changing circumstances. NER300 project selection and award process was complex and lengthy but failed to address the key issue of economic viability. NER300 included requirements that **favoured smaller projects over larger ones** (and so disadvantaged projects with large CO_2-abatement impact such as large-scale CCS projects):

1) Eligible projects could not benefit from national funding if they were not also benefitting from European funding.
2) The 15% funding limit of the total project value from NER300 had a clear detrimental effect on large-scale CCS projects.
3) Also, the NER300 requirement for Member States (MS) to match any funding award was one of the reasons why no CCS projects could receive funding in the first round of the NER300.

The financial crisis combined with the collapse of the EU ETS price, were two factors which led to some MS cutting back on projects. As a result, these projects became ineligible for NER300 funding.

The Innovation Fund is **more flexible**:

- It improves the risk-sharing for projects, as its grants cover up to 60% of the additional capital and operational costs of innovation
- The cash flow resulting from funding of the project is ensured through pre-defined milestones
- Simplified selection process
- Allows synergies with other EU funding programmes, which is critical to achieve the necessary support Streamlined governance and simplified decision-making

Compared to the past, there is **stronger coordination between the Commission and Member States**. As an example, in 2015, the Commission implemented the SET-Plan, where a dedicated working group on CCS and CCU now provides the Commission, Member States and stakeholders an opportunity to update on the progress of projects and address policy and economical barriers.

Moreover, the recognition of CCS in the Sustainable Finance taxonomy as "an economic activity which contributes to climate change mitigation" can help channel private investments, in addition to public funds, towards CCS scale-up.

[2] European Court of Auditors (2018): *Demonstrating carbon capture and storage and innovative renewables at commercial scale in the EU: intended progress not achieved in the past decade*: https://www.eca.europa.eu/Lists/ECADocuments/SR18_24/SR_CCS_EN.pdf
[3] Global CCS Institute. *CO2RE Database*: https://www.globalccsinstitute.com/resources/co2re/
[4] High-Level Group on Energy Intensive Industries (2019). *Masterplan for a Competitive Transformation of EU Energy-intensive Industries Enabling a Climate-neutral, Circular Economy by 2050*: https://ec.europa.eu/docsroom/documents/38403

3) Low carbon/clean hydrogen: Extending the climate benefits of CCS beyond the power sector

Natural gas can be reformed to hydrogen with CCS to support the decarbonisation of the EU **industrial, transport and heating sectors** in addition to power generation. The versatility of hydrogen as an energy carrier is shown by its potential to tackle difficult emissions across various sectors of the economy. In 2018, six new large-scale CCS projects were listed in the Global CCS Institute database[3] - all are in Europe, and all are related to the production of hydrogen from natural gas with CCS. The hydrogen revenue from such projects can help **underpin and finance the integrated CCS component**.

As recognised by the High-Level Group on Energy-intensive Industries[4], the EU will require increasingly higher quantities of low carbon/clean energy - including both electricity and hydrogen. To ensure sufficient volumes, all low carbon/clean hydrogen production pathways need to be supported, taking into account that hydrogen from natural gas reforming with CCS has greater potential in the short term to enable scalable production. The transition of the EU industries to climate neutrality **requires a cross-sectoral approach**, a supportive legal framework allowing the transition at globally competitive conditions, and the timely development of adequate infrastructure.

The industrial sector, with its sizable hydrogen demand, and its existing infrastructure, offers a potential early market for low carbon/clean hydrogen. The reforming of natural gas to hydrogen is already an **established and deployed technology** in the industrial sector, and coupling this process with CCS, allows the production of low carbon/clean hydrogen. Hydrogen use today is dominated by industrial applications, as the top four single uses of hydrogen globally are: oil refining (33%), ammonia production (27%), methanol production (11%) and steel production via the direct reduction of iron ore (3%).[5]

- **More than 60% of hydrogen used in refineries today is produced by reforming of natural gas (the remaining being produced by reforming of liquid hydrocarbons)**. Future demand for low carbon/clean hydrogen is likely to arise from existing facilities already equipped with hydrogen production units, suggesting an opportunity for retrofitting with CCS as a suitable option to reduce emissions.[6]
- **Global demand for ammonia and methanol is expected to increase**. New capacity additions offer an important opportunity to scale up low carbon/clean hydrogen pathways.
- **Steel and high-temperature heat production offers vast potential for low-carbon/clean hydrogen demand growth**. Solutions based on CCS will be necessary in addition to hydrogen produced from electrolysis using excess renewable electricity. While it should be technically possible to produce all primary steel with hydrogen based on electrolysis, this would require vast amounts of excess renewable electricity (around 10% of global electricity generation today) and would only be economic without policy support at very low electricity prices.

Europe is furthermore well placed to benefit from its **extensive natural gas pipeline infrastructure**, which can be adapted or repurposed to transport hydrogen to various end-uses, achieving emission cuts in sectors which would be hard to electrify, while upstream pipelines (in particular North Sea ones) could also be repurposed to transport hydrogen or CO_2.

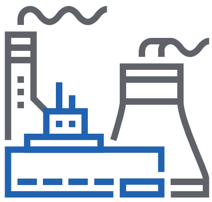
[5] See Chapter 4: Present and potential industrial uses of hydrogen, in IEA (2019). *The Future of Hydrogen*
[6] See for example the Preem CCS project: https://www.preem.com/in-english/press/

In this context, there **it would be adequate to have in place a regulatory framework which incentivises the reductions of GHG emissions for instance by**:

- **Promoting a market framework for low carbon products and services including those produced with CCS, including Guarantees of Origin and/or other accreditation schemes, to incentivise new business models and support market uptake.**
- **Enable transportation of CO_2 as a commercial or regulated activity as part of gas market legislation;**
- **Ensure that CCS projects are eligible for EU funding (CEF, Horizon Europe, Innovation Fund) ; support for CCS should be "at least equivalent" to support given to other low carbon technologies (such as renewables)**
- **Encourage Member States to include strategies for CCS deployment in their updated National Energy and Climate Plans (NECPs).**

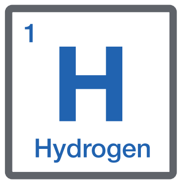
A list of other policy asks is available in the report 'The potential for CCS and CCU in Europe' coordinated by IOGP for the 32nd meeting of the European Gas Regulatory Forum here.

Where can CCS make a difference?



Emission cuts in **industrial processes** where mitigation potential is high, like steel, cement/lime, chemicals, and refining

Low-carbon, flexible **electricity from gas-fired power plants with CCS** to complement an energy system with a growing share of variable renewables



Large-scale production of **hydrogen from natural gas with CCS**, providing clean energy for industry, power, transport and heating