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A review on policy framework for carbon capture, utilization and storage in the EU

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A review on policy framework for carbon capture, utilization and storage in the EU

Deliverable 3.1 of the VTT RePowerEU programme project on CO_2 capture and supply for P2X processes

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1. Introduction

Drastic actions are urgently needed in the battle against climate change. Slow pace and inadequacy of our actions on mitigating greenhouse gas emissions requires that new tools are needed in the climate action portfolio. Renewable energy, energy efficiency improvement, and management of natural carbon sinks remain as top priorities, but now high expectations are also placed on carbon capture, utilization, and storage (CCUS). Supportive policy making is needed to accelerate deployment of novel CCUS value chains, in which the European Union is showing good progress.

2. What is CCUS?

Carbon capture refers to capturing CO_2 from emission point sources of industry or energy production, or even directly from the atmosphere. To avoid releasing the captured CO_2 to the atmosphere it can be permanently stored to underground geological formations or bound to stable minerals via carbon mineralization. Alternatively, the CO_2 can be utilized as feedstock for fuels, materials, chemicals, or processes – preferably to replace the use of virgin fossil sources. Commonly, transport of CO_2 from the capture location to the end-use location is also required. In the EU, the various value chains for CO_2 capture, transport, storage, and utilization as well as removing carbon from the atmosphere by technological means are referred to as industrial carbon management (Figure 1).

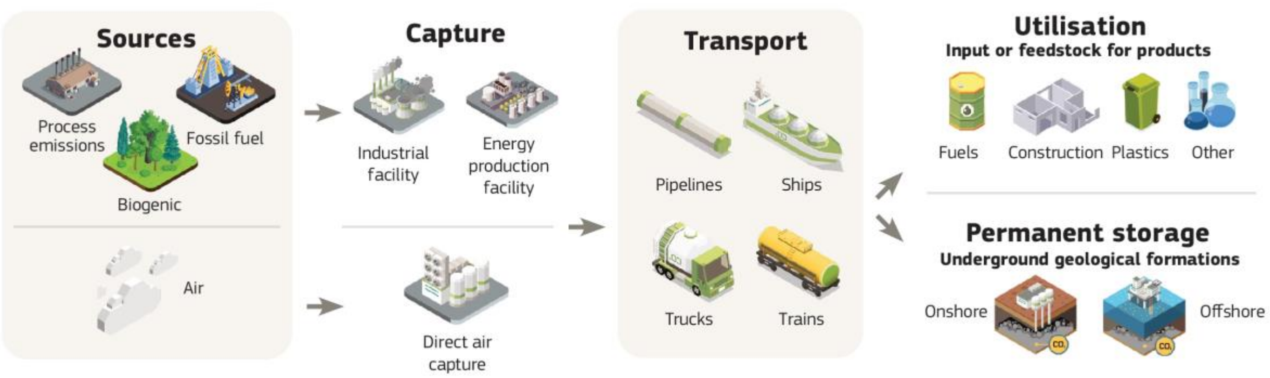

Figure 1. Industrial carbon management pathways (European Commission 2024a).

Carbon capture value chains are commonly categorized depending on the origin of the captured CO_2 (fossil, biogenic or atmospheric) and the end-use application (storage or utilization). CCS (*carbon capture and storage*) and CCU (*carbon capture and utilization*) are often used to refer to capture and storage or utilization of fossil CO_2. However, CCS and CCU – or combined together as CCUS – can be also used as roof terms to cover all capture and storage or utilization value chains when origin of the CO_2 is not specified. BECCS (*bioenergy with carbon capture and storage*) and BECCU (*bioenergy with carbon capture and utilization*) refer to capture and storage or utilization of biogenic CO_2. Similarly, DACCS (*direct air carbon capture and storage*) and DACCU (*direct air carbon capture and utilization*) refer to capture and storage or utilization of atmospheric CO_2.

3. Climate impact of CCUS

Climate impact of CCUS depends on origin of the captured CO_2 as well as the end-use application and its storage permanence. Figure 2 presents the flow of carbon in various carbon capture value chains by the CO_2 origin and the end-use application.

Capture and permanent storage of fossil CO_2 reduces emissions compared to operation without capture, but carbon in the atmosphere still increases as all the CO_2 cannot be typically captured. If the CO_2 is of biogenic or atmospheric origin, capturing and permanently storing it reduces the amount of carbon in the atmosphere as CO_2 is permanently removed from the natural carbon cycle, where carbon flows between organisms and the atmosphere.

In utilization, the CO_2 is typically stored only temporarily into a product or a process and released over time. Therefore, climate impact of CO_2 utilization derives primarily from replacing the use of virgin fossil sources. If CO_2 of fossil origin is captured and utilized it can reduce the flow of virgin carbon into the system, but the amount of carbon in the atmosphere increases over time as the utilized CO_2 is eventually released. If the utilized CO_2 derives from biogenic or atmospheric origin it can eliminate the flow of virgin carbon into the system, whereas the amount of carbon in the atmosphere remains unchanged over time as CO_2 cycles between the utilization products or processes and the natural carbon cycle.

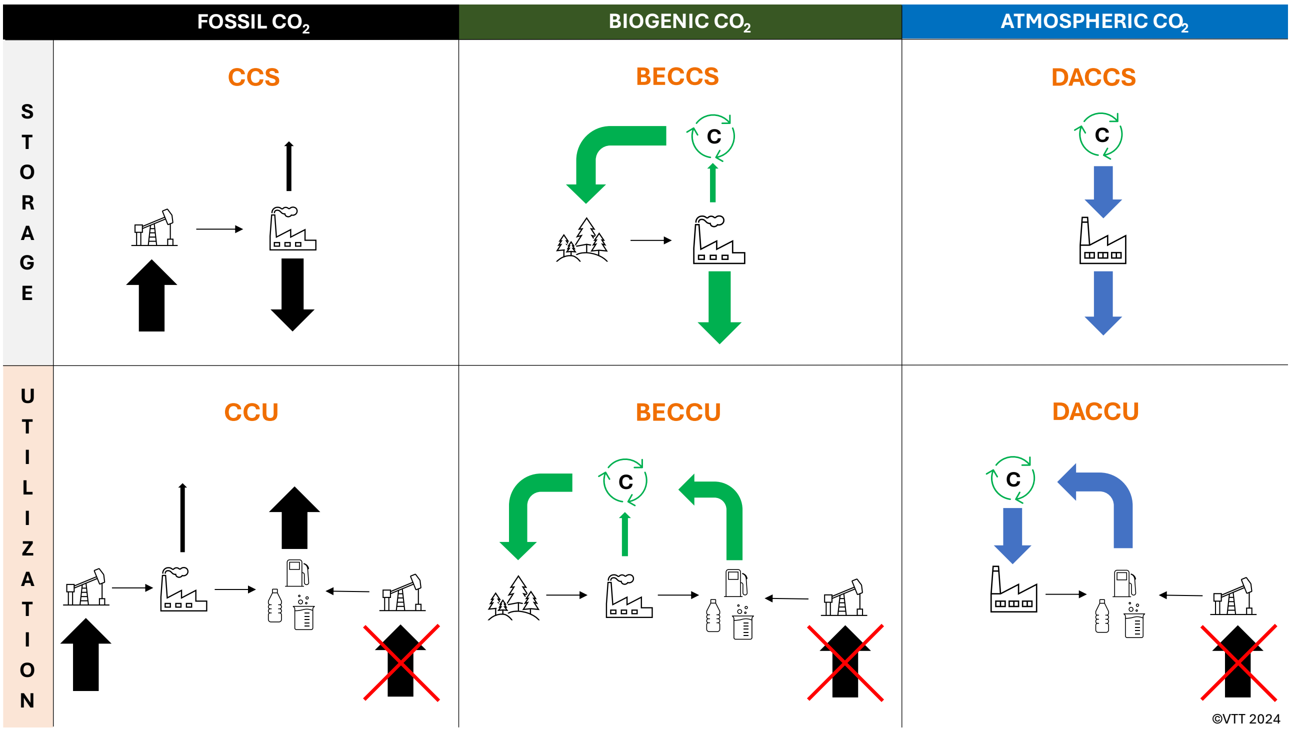

Figure 2. Carbon flow in carbon capture value chains by the CO_2 origin (fossil, biogenic or atmospheric) and the end-use application (storage or utilization).

To realistically evaluate the climate impact of CCUS it is essential that any additional CO_2 originating from implementation of the value chains are accounted for, e.g., emissions deriving from CO_2 transport or increased energy demand.

4. Carbon capture is critical for climate goals

According to experts, carbon capture is a critical complementary technology in climate change mitigation alongside the more common measures such as increasing renewable energy capacity, improving energy efficiency, and taking care of the natural carbon sinks.

IEA (2023a) estimates that annual CO_2 capture capacities of 1 Gt by 2030 and 6 Gt by 2050 should be in place globally to reach net-zero emissions by 2050. Scenario modelling by the IPCC (2022) suggests that limiting global warming to 1.5°C could require global cumulative carbon removals of 30–780 $GtCO_2$ with BECCS and 0–310 $GtCO_2$ with DACCS by the end the century. The vast CO_2 capture capacities of these scenarios indicate that carbon capture technologies should be urgently deployed.

5. Supportive policies are needed to deploy CCUS

Regardless of the urgency, actual progress on CCUS has been moderate so far. According to IEA (2024), global operating capacity of carbon capture is only 50 Mt in 2024. Both the IPCC (2022) and IEA (2023b) state that more efforts are needed in to stay on track in their climate scenarios.

Slow progress can be partly blamed on lack of comprehensive policy framework, leaving the stakeholders unwilling to carry the risks of the novel technologies before the table has been set to enable them to safely plan ahead. Due to high initial investments and novelty of the business models most carbon capture value chains are not feasible unless supported by proper policies. Therefore, if the technology is seen critical to combat climate change – as the experts do – necessary supportive policies must be developed to deploy carbon capture value chains. This has been noted in the European Union, where policy making on the topic has swiftly taken off after CCUS and carbon removals were recognized as key technologies in the EU's climate action portfolio.

6. Policy drivers for CCUS in the EU

EU's recent communication on the 2040 Climate Target (EU Communication 2024/63) states that CCS, CCU and carbon removals are necessary to decarbonize the energy system alongside other zero and low emission energy solutions. Additionally, it is noted that any remaining fossil fuel combustion will be coupled with carbon capture as soon as possible. Impact assessment report of the 2040 Climate Target (European Commission 2024b) suggests that around 280 $MtCO_2$/a by 2040 and 450 $MtCO_2$/a by 2050 should be captured in the EU, including fossil-CCS, BECCS, DACCS and CCU. As a reference point, the current annual industrial CO_2 emissions reported under the European Pollutant Release and Transfer Register are around 1300 Mt (EEA 2024).

EU has several policy instruments that promote deployment of carbon capture technologies.

- The European Climate Law (EU Regulation 2021/1119) acknowledges CCS, CCU and carbon removals as relevant approaches for the Member States to choose in their decarbonization pursuits.

- Industrial Carbon Management Strategy (EU Communication 2024/62) aims to outline a holistic EU strategy for carbon capture, utilization, and storage, as well as technological carbon removals. It provides a framework for policy development, guidance and boosting of research and innovation. The strategy suggests upcoming policies, for instance, on CO_2 quality standards, CO_2 supply and demand aggregation platform, and accounting rules.
- Net-Zero Industry Act (EU Regulation 2024/1735) raises CCS, CCU and CO_2 transport to the list of strategic net-zero technologies, which should ensure them a priority status at national level, accelerated permitting processes, and facilitated access to public tenders and support schemes. The act also includes an annual CO_2 injection capacity target of 50 Mt within the EU by 2030 and promotes the creation of European CO_2 storage atlas, while obligating oil and gas companies to contribute to its creation.
- Communication on Sustainable Carbon Cycles (EU Communication 2021/800) suggests that at least 20 % of the carbon used in chemical and plastic products should come from sustainable, non-fossil sources by 2030. Furthermore, any ton of CO_2 captured, transported, used, and stored by industries should be reported and accounted by its fossil, biogenic or atmospheric origin by 2028. Also, 5 Mt of CO_2 should be annually removed from the atmosphere and permanently stored through frontrunner projects by 2030.
- CCU fuels are promoted for the transport sector by several policies. Renewable Energy Directive (EU Directive 2023/2413) set targets for the use of renewable fuels of non-biological origin (RFNBO's) in transport sectors. ReFuelEU Aviation (EU Regulation 2023/2405) set targets for the use of Sustainable Aviation Fuels (SAF's) and synthetic fuels in aviation sector. FuelEU Maritime (EU Regulation 2023/1805) sets GHG intensity reduction targets for the maritime sector, including a reward factor for RFNBO use.
- Trans-European Networks for Energy (EU Regulation 2013/347) supports development of carbon dioxide transport networks for permanent storage purposes, enabling such projects to apply for a status of project of common interest (PCI's) or project of mutual interest (PMI's).
- EU has several funding instruments that can support development and deployment of CCUS. Horizon Europe funding programme (European Commission 2024c) supports research and innovation projects, whereas the Innovation Fund (European Commission 2024d) supports deployment of net-zero and innovative technologies, also including projects on carbon capture, use and storage. Connecting Europe Facility - Energy programme (European Commission 2024e) can provide funding for Trans-European energy networks and infrastructure applicable for projects of common interest such as CCS infrastructure.

7. Regulatory framework for CCUS in the EU

In addition to the policy drivers, EU has set out regulatory instruments aiming for safety, compliance, and proper standards for implementation of carbon capture technologies and value chains.

- Emissions Trading System (ETS) directive (EU Directive 2009/29/EC) enables avoiding to surrender ETS allowances for fossil CO_2 that is captured and permanently storage if storage permanence is proven.
- CCS directive (EU Directive 2009/31/EC) outlines the regulation for transport and geological storage of CO_2, including storage site selection criteria, safety standards, environmental impact assessment, and monitoring.
- Production rules for renewable fuels of non-biological origin (RFNBO) are detailed in EU Delegated Regulation 2023/1184, while the methodology for determining the greenhouse gas (GHG) savings threshold for recycled carbon fuels (RCF) and assessing the GHG savings of RFNBO's is outlined in EU Delegated Regulation 2023/1185.
- Monitoring and Reporting Regulation (EU Implementing Regulation 2018/2066) lays down rules for monitoring and reporting of greenhouse gas emissions, also taking into account CO_2 capture installations. It also states that surrendering ETS allowances can be avoided for CO_2 that is bound into precipitated calcium carbonate.
- The Monitoring and Reporting Regulation was recently amended regarding ETS accounting of RFNBO's and RCF's (EU Implementing Regulation 2024/6542). The amendment states that the carbon content of fuels qualifying as RFNBO's or RCF's shall be considered zero-rated. Also, to avoid double-counting CO_2 captured for production of RFNBO's or RCF's under an activity covered by the ETS should be accounted for under that activity, whereas the produced RFNBO's and RCF's should have an emission factor of zero.
- Carbon Removals and Carbon Farming Certification (CRCF) Regulation (EU Proposal 2022/672) establishes an EU-wide voluntary framework for certification of carbon removals, carbon farming and carbon storage in products, laying out quality criteria and monitoring and reporting obligations. Detailed methodologies will be developed in upcoming delegated acts.
- Delegated act on permanent emissions storage through carbon capture and utilization (EU Delegated Regulation 2024/5294) outlines the criteria for products chemically binding CO_2, allowing to avoid surrendering ETS allowances from the bound CO_2. Currently, the products considered to permanently chemically bind CO_2 include mineral carbonates used in the following products: carbonated aggregates in construction products, carbonated constituents of cement, lime, or other binders, carbonated concrete including precast blocks, pavers, or aerated concrete, carbonated bricks, tiles, or other masonry units.

8. Upcoming regulation for CCUS in the EU

Regulation will be further complemented in the EU to clarify the necessary quality criteria, production methodologies, monitoring, verification, and accounting. As of now, at least the following policy topics have been communicated for the future.

- A draft on EU Delegated Regulation 2024/1788 on low-carbon fuels was published for feedback on 27.9.2024 and is planned to be adopted by the end of 2024. The act aims to set out the methodology to determine the GHG emission savings of low-carbon hydrogen and low-carbon fuels.
- The 2026 revision of EU ETS will assess how permanent carbon removals could be integrated into EU ETS, evaluate emission accounting and double counting regarding non-permanent utilization of CO_2, and assess feasibility of including municipal waste incineration installations into EU ETS and the role of non-permanent CCU in such applications.
- CRCF delegated acts for BECCS and DACCS will detail methodologies for producing carbon removals via permanent storage of biogenic or atmospheric CO_2.

9. Take part to make a difference

Effective policy making requires active dialogue between legislators, stakeholders, experts, and the public. Different parties can take part in EU's policy making, for instance, by participating in public consultations regarding new policy initiatives (European Commission 2024f) and by attending advocacy and expert groups such as the Industrial Carbon Management forum that includes participants from non-governmental organizations, research institutes, government bodies, academic institutions, and the industry (European Commission 2024g).

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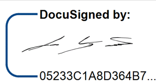
Lauri Kujanpää lauri.kujanpaa@vtt.fi Research Team Leader Security Level: Email, Account Authentication (None), Authentication	 Signature Adoption: Pre-selected Style Using IP Address: 130.188.31.3	Sent: 21 November 2024 | 14:10 Resent: 29 November 2024 | 09:13 Resent: 09 December 2024 | 14:41 Viewed: 09 December 2024 | 14:43 Signed: 09 December 2024 | 14:44

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