Factsheet

Carbon Capture & Utilisation

More than a Carbon Removal Technology!

What is Carbon Capture and Utilisation (CCU)?

Carbon Capture and Utilisation (CCU) describes a **diverse set of technologies** that allow for the capture and use of **carbon dioxide (CO_2) as a renewable feedstock** for essential products such as fuels, chemicals and building materials, that today are predominantly derived from fossil resources.[1]

CO_2 emissions can either be captured directly from the air (direct air capture, DAC) or from point sources. In the latter case, especially sectors with high emissions such as cement production, waste incineration and wastewater treatment are particularly suitable as point sources. Estimations foresee that 21% of GHG reductions from technologies will come from CCU, reducing CO_2 emissions by about 250 Mt in the EU by 2050[2], and that the total production capacity of novel CO_2-based products will increase from 1.3 Mt per year in 2022 to 6 Mt per year in 2030[3].

This way, CCU contributes to a **circular economy** in which the emissions at the end of life of a product are again captured and used to make new products. Combined with bio-based solutions and recycling, CCU can contribute to a fossil free future. Furthermore, CCU can become a **carbon-negative technology** if its energy demand is covered by renewable energy sources, and if the captured CO_2 is bound in high volumes and in products with a high longevity.

What is the difference between CCU and Carbon Capture and Storage?

Carbon capture and utilisation (CCU) and carbon capture and storage (CCS) are both strategies aimed at mitigating CO_2 emissions, however, they differ in their approach and ultimate outcomes. CCS involves capturing CO_2 emissions from industrial processes or power plants and storing them long-term underground in geological formations, such as depleted oil and gas reservoirs or deep saline aquifers. CCU, on the other hand, aims at using CO_2 as feedstock and keeping this carbon source in the industrial cycle, preventing the additional tapping of fossil carbon from the ground. This way, CCU prevents CO_2 from re-entering the atmosphere. Therefore, a **comprehensive carbon management** requires a combination of CCU and CCS in order to

- **reduce** excess atmospheric **CO_2 emissions,**
- successfully **mitigate climate change,**
- use **CO_2 as valuable feedstock,** and
- **keep fossil carbon underground.**[4]

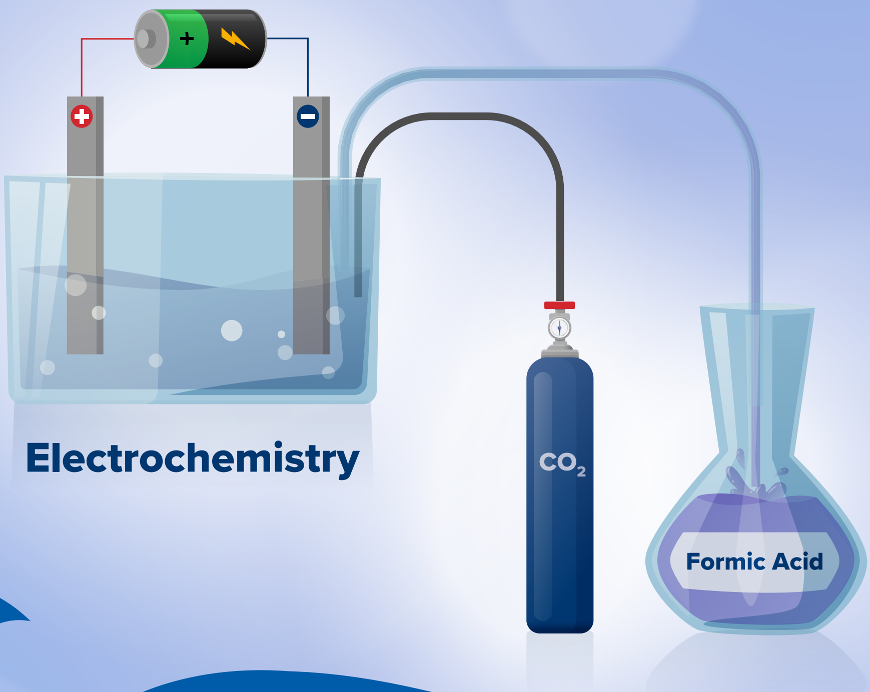
As soon as CCU technologies are industrially upscaled, CCU can completely supersede CCS as it is faster, cheaper and more environmentally friendly.[5]

How to make CCU sustainable?

CCU technologies generally have a high energy demand because of energy-intensive steps such as CO_2 capture, purification and chemical conversion. However, the energy demand of CCU can be mitigated through several approaches:

- Use renewable energy sources like solar, wind or hydroelectric power instead of fossil energy, thus mitigating emissions associated with energy generation.
- Improve energy efficiency by optimising CCU processes, improving equipment efficiency, and reducing energy losses.
- Integrate CCU facilities with existing industries to utilise waste heat or by-product gases to fuel the CCU processes.

Despite its high energy requirements, CCU is worthwhile as it offers a multitude of advantages[4], such as opportunities to reduce carbon emissions and to create value from CO_2, **contributing to the UN Sustainable Development Goals**[6]. Furthermore, CCU enables **regional self-sufficiency** of carbon feedstock because both renewable energy and CO_2 emissions can be tapped anywhere on the globe.



Which products can be derived from CCU?

CCU offers a sustainable approach to utilize captured CO_2 across various industries by converting it into essential products. These cover three main categories[1]:

Fuels

CCU fuels provide solutions for sectors like aviation and heavy transportation where fossil fuels are hard to replace. These fuels reduce further emissions and utilise existing infrastructure. Technologies for CCU fuels already exist, with the first flight using CCU kerosene in 2021.

Chemicals

CO_2 emissions captured in the CCU process can be converted into base chemicals such as formic acid, acetone, methanol, ethanol or other hydrocarbons. These can be used to substitute fossil carbon in products such as plastics, chemicals and textiles. Commercialised products like cleaning products and insulation materials are already available.

Materials

CCU can permanently bind CO_2 in construction materials, reducing emissions in sectors like building. By carbonating abundant mineral waste fractions, CCU creates materials like bricks and tiles, reducing the need for landfills and new mineral extraction.

Policy support for CCU in the EU

→ The **Net Zero Industry Act (NZIA)** recognises CCU as a net zero technology and as an eligible strategic technology to reaching net zero CO_2 emissions by 2050[7].

→ In 2024, in a **provisionally regulation** of the European Parliament and the Council a political consensus was reached **on an EU-wide certification scheme for carbon removals** (by technologies such as CCU and CCS). As soon as the regulation is formally approved, the new legislation will enter into force.

→ The EU's Innovation Fund and Horizon Europe programme provide **funding and support for CCU projects,** encouraging collaboration between industry, academia, and research institutions to develop innovative CCU technologies and solutions.

→ In the **Communication on Industrial Carbon Management**[8], the European Commission provides details on how carbon removal technologies (including CCU) could contribute to reducing emissions by 90% by 2040 and reaching EU climate neutrality by 2050.

CCU in WaterProof

The Horizon Europe project WaterProof (urban Waste and water Treatment Emission Reduction by utilizing CO_2 for the PROduction Of Formate derived chemicals) aims at developing an electrochemical process that converts CO_2 emissions captured from consumer waste incineration and wastewater treatment facilities into formic acid. The formic acid will then be used in valuable green consumer products such as cleaning detergents and as tanning agent for fish leather apparel. Furthermore, CO_2-derived formic acid is used for the generation of acidic deep eutectic solvents (ADES), that can be applied to recover precious metals from wastewater sludge and incineration ashes. By making use of renewable energy for the electrochemical process, it contributes to a clean water cycle with zero-emission. At the end of the project, the WaterProof technology will be upscaled and a conversion pilot factory will be erected. WaterProof enables the closing of the waste(water) carbon loop and the shift from fossil to renewable carbon sources. It hereby supports the transition towards a climate-neutral Europe and an effective and truly circular economy.

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