

Carbon Capture Utilization and Storage (CCUS)

Tech for Net Zero Knowledge Poster #5

An introduction to carbon capture

Carbon capture, utilization and storage (CCUS) refers to the process of capturing **carbon dioxide** (CO₂) from various sources, including directly from plant sites or from the air. The captured CO₂ can then be used in **industrial applications** or **stored long-term** in deep geological formations, preventing its release into the atmosphere.

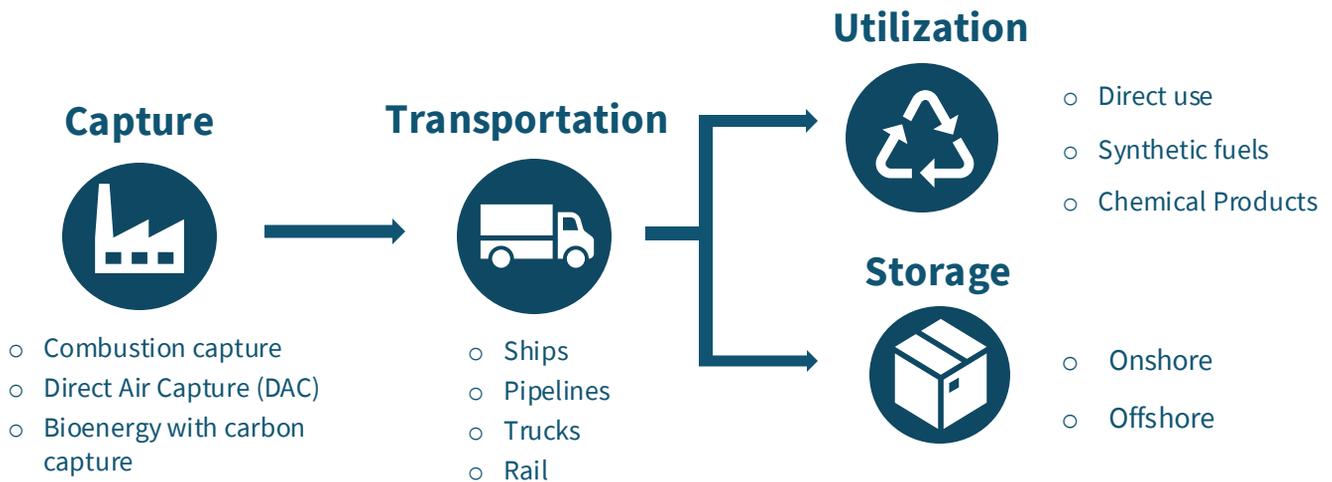


Why is carbon capture necessary?

The Intergovernmental Panel on Climate Change sees CCUS as part of net-zero pathways. But **storage capacity** is limited and the energy required to capture and store CO₂ at scale is enormous. CCUS should therefore be reserved for truly hard-to-abate sectors and **unavoidable residual emissions**, not as a substitute for direct emissions reductions.



Overview of the CCUS value chain



Sources: CETO (2025); IEA (2024)

The technologies behind carbon capture

Solvent-based absorption

- Flue gas comes into contact with a solution containing amines that bind to the CO₂. Heating in a stripper then separates the CO₂, creating a pure stream.
- Amine solvents are the most commonly used method of post-combustion capture commercially today.
- The TRLs of different solvent-based absorption methods: amine solvents 9; hot potassium carbonate 9; chilled ammonia 6–7; phase-change and water-lean 6.

Adsorption with solid sorbents

- CO₂ binds to porous solids. In temperature and pressure swing absorption (TSA/PSA), the CO₂ is released through regeneration, allowing the sorbent to be reused continuously.
- This process is currently used commercially in high-pressure process streams for hydrogen production via SMR and in some DAC plants.
- The TRLs of CO₂ capture via adsorption methods: PSA/VSA 9; TSA 7–8; enzyme-catalyzed adsorption 6.

Membranes

- CO₂ permeates through a selective membrane under pressure gradient; retentate is depleted, permeate enriched stream collected. The advantage of this technology over others is that hazardous chemicals are excluded.
- Application of membrane capture remains limited, trailing solvent absorption and adsorption deployments today.
- TRLs: gas-processing membranes 9; polymeric 7; electrochemical 7–8.

Sources: CETO (2025); Global CCS Institute (2025); IEA (2024)

Recent Developments on CCUS in Germany

➔ The **CO₂ Storage and Transport Act** came into force in November 2025. This legislation permits the commercial storage and transport of CO₂ in Germany. Alongside the enabling legislation for offshore storage, passed in January 2026, the revised framework **permits commercial geological storage offshore**, subject to defined safeguards and planning restrictions, including protections for sensitive marine areas.

➔ Onshore storage is generally excluded beyond research-scale projects, but German **federal states can opt in for industrial-scale onshore storage** through state legislation. Germany has also taken steps to enable **cross-border CO₂ transport and export** for offshore storage, thereby aligning national regulations with international arrangements.

➔ Germany's government is planning a **Carbon Management Strategy** to identify the areas in which CCUS is necessary. The strategy will serve as a framework for successfully ramping up the technology and focus on the necessary infrastructure. Additionally, the **Long-Term Strategy on Negative Emissions** will establish targets for a negative greenhouse gas balance in Germany beyond 2045 and outline the steps to achieve them.

Source: German Bundestag (2026); German Federal Government (2025)

Policy recommendations to enable CCUS scale-up

- **Innovate to Cut Carbon Capture Costs:** Accelerate R&D, grants, and carbon pricing to drive technological breakthroughs, making carbon capture cheaper and less energy-intensive. Fast innovation reduced operating cost and ensures CCUS has a business case.
- **Prioritize Carbon Use Over Storage:** Encourage the production of syngas and synthetic fuels to absorb captured carbon and turn emissions into circular products. Geological storage should remain a last-resort solution for emissions with no reuse pathway.
- **Polluters Pay, Not Taxpayers:** CCS costs must fall on corporates through carbon pricing, advance market commitments (AMCs), and liability frameworks. Leverage private finance for CCUS infrastructure with guarantees to ensure financial sustainability without burdening public budgets.

Carbon capture technologies in the Tech for Net Zero network

Climeworks runs DAC technology in which fans draw in ambient air and pass it through a sorbent that binds the CO₂. The concentrated CO₂ is then collected and stored underground. The company sells carbon removal certificates to other businesses or individuals.



Greenlyte

Greenlyte is working on a DAC-to-fuels platform. Captured CO₂ is transformed into a highly concentrated salt that is used as an electrolyte in the production of hydrogen. The resulting carbon and green hydrogen can then be used as feedstocks for e-fuels.

NeoCarbon's technology captures CO₂ from the air using low-grade waste heat that is already produced by industrial sites. This enables customers to reduce operating costs while also generating revenue from carbon credits or supplying CO₂ on site for industrial processes.

NEOCARBON

PHLAIR

Phlair operates a hydrolyzer-based DAC technology. CO₂ is absorbed from the air into a basified sorbent and then released as high-purity CO₂ via acidification. A proprietary hydrolyzer uses renewable electricity to regenerate the acid and base.

Ucaneo captures CO₂ in the form of a stable bicarbonate through a biomimetic solvent from ambient air. An electrochemical stack with biocatalysts and electro dialysis is then used to concentrate and release a continuous stream of high-purity CO₂ at room temperature.

UCANEO