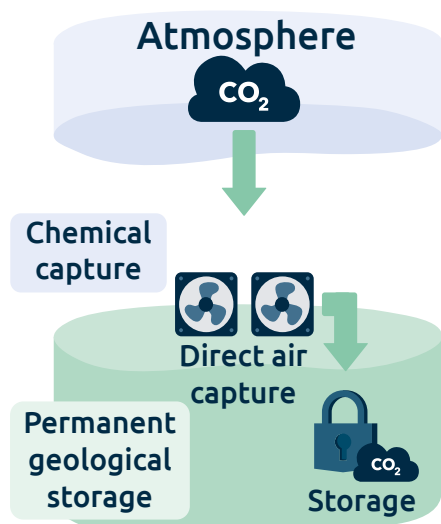


DACCS



A process that removes CO₂ directly from the atmosphere



Expected permanence	millennia
Reversal risk	low
Uncertainty in amount of initially captured carbon	low
Uncertainty in amount of carbon stored over time	low
Ease and accuracy of MRV	high
Key benefits	none

What is DACCS and how does it store carbon?

Direct air capture refers to the chemical extraction of CO₂ from the atmosphere by chemical adsorption, followed by the recovery and compression of CO₂ into a concentrated liquid, and storage in geological reservoirs, commonly known as DACCS. It is an example of removals with easy MRV because the capture and storage processes are relatively easy to quantify and measure. The process to separate CO₂ from the other components of ambient air is either done through absorption or adsorption. Once extracted, the carbon is then stored in geological reservoirs such as saline aquifers, or in other mineral forms in the Earth's crust.

Solid sorbent and liquid solvent DACCS are two common approaches used to capture CO₂ directly from the air. In the liquid solvent DACCS process, high-grade heat (900°C) is supplied by natural gas or hydrogen, with electricity sourced from the power grid. CO₂ emissions resulting from natural gas combustion are assumed to be captured within the plant limits. In the solid sorbent DACCS process, heat and electricity are both obtained from the power grid, using an industrial heat pump which converts electricity to low-grade heat (100°C). Newer capture technologies use more economical, reversible carbonate-based chemical reactions (carbonation and calcination), which are cheaper.

As of February 2024, there are over 20 DAC/DACCS initiatives in Europe. Current capacity at one of the largest plants in operation ([ORCA](#)) is on the scale of 4000 tons of CO₂ each year.

Relevant regulatory framework:

Geological storage is currently regulated under the [EU CCS Directive \(2009/31/EC\)](#). According to the IEA, potential cross-boundary CO₂ transport may be regulated under the London Protocol, once ratified, or by other options that align with applicable international law.

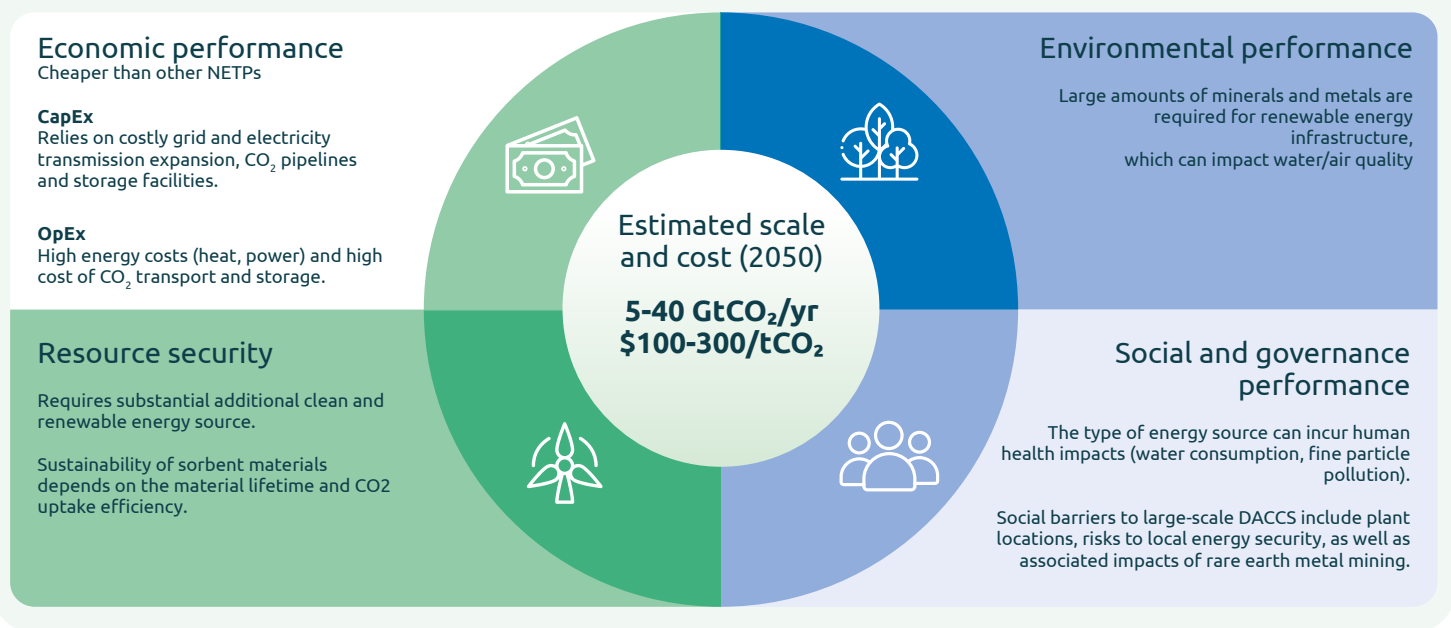
ADVANTAGES

- PERMANENT STORAGE**
Sequestered carbon is stored permanently with low risk of reversal.
- TRL**
DACCS is one of the more developed technologies (TRL 6). It is already being piloted.
- MRV**
Easy to quantify how much carbon is removed and stored. Baseline definition is straightforward and DACCS is, by default, considered additional.
- ENVIRONMENTAL BENEFITS**
Low impacts on terrestrial biosphere, generally not constrained by biophysical limitations and may provide valuable freshwater source in arid regions.

CHALLENGES

- ENERGY INTENSIVE**
Dependent on plentiful (and renewable) energy and heat source. Approximately 200mk² of non-arable land is needed for renewable energy generation to remove 1 Gt of CO₂.
- COST**
Costs are high and infrastructure is expensive to build.
- PLANT LOCATION**
Limitations on plant location due to necessary proximity to renewable energy supply. Storage capacity limited due to low current capacity of stable and permanent storage reservoirs.
- FEW CO-BENEFITS**
DACCS has fewer associated co-benefits compared to nature-based CDR technologies or BioCCS.

What is the sustainable potential of DACCS to sequester carbon?



Current unknowns and future research perspectives

DACCS is currently expensive and its future cost is hard to predict. Experts believe that economies of scale, process optimisation, including the development of more efficient and less costly sorbents, will eventually decrease sorbent fabrication costs. Greater availability and subsequent lower cost of renewable energy, could significantly reduce the energy costs of the technology. Options include novel configurations/tech that use carbonation cycles rather than sorbent materials. Regulation is currently limited to CO₂ storage in geological storage sites under the EU CCS Directive (2009/31/EC), which also sets out clear liability and monitoring mechanisms. However, clear international or European regulatory framework for the cross-boundary transport of carbon has not yet been developed.

Policy recommendations



Support renewable energy development to ensure DACCS-related energy requirements can be accommodated, as opposed to further straining energy demand on partially-renewable energy systems. This avoids harmful health impacts arising from non-renewable electricity generation.



Acknowledge the uneven distribution of domestic capacity for renewable energy and permanent carbon storage for DACCS. Prioritise DACCS in regions where renewable energy is plentiful and ensure that the energy required for DACCS does not detract from grid decarbonisation. Ideally, locate DACCS plants in proximity to geological storage sites.



Coordinate transboundary CO₂ transport and storage to achieve DACCS deployment at scale. Create legal instruments that include socio-political and ethical compensation or incentivisation mechanisms for Member States that are expected to host optimal DACCS. Respect sovereign rights to equity and development in transboundary initiatives with third countries.



Ensure that policies coordinate key industries involved in capture, storage and transport of CO₂ and give certainty to stakeholders, incentivise financial investment and establish secure business models.

Relevant literature

Cobo et al. 2022 [↗](#)

OECD/IEA report "Carbon Capture and Storage and the London Protocol" 2011 [↗](#)

NEGEM Deliverables: D1.5, D2.1, D3.8, D3.9, D4.5, D5.2, D5.4, D6.3, D7.2, D8.2 [↗](#)