INNO-CCUS
Carbon capture, utilisation and storage

Insight: Direct air capture will be critical to meeting Denmark's 2050 climate target – that's why we must start in 2025

In April 2025, the Danish government published - for the first time - a climate projection and status update outlining the full pathway to the 2030 target of 70% CO_2 reduction. That was welcome news. But now, it's time to look further ahead: to 2050.

Denmark's ambition is not only to become CO_2-neutral, but climate positive by 2050. That means removing more greenhouse gases from the atmosphere than we emit. Achieving that vision requires both deep emissions reductions and the deployment of technologies that can actively extract CO_2 from the air.

One of the most promising technologies in this space is Direct Air Capture (DAC). This method makes it possible to remove CO_2 directly from ambient air and store it permanently. DAC is particularly compelling because it can address two major climate challenges:

Historic emissions – the CO_2 already released over decades

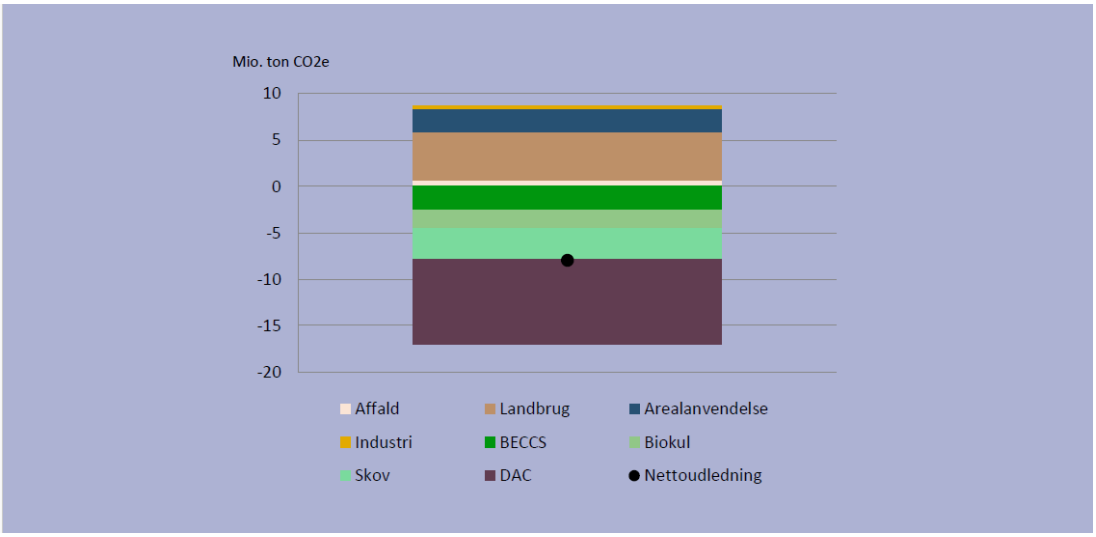
Residual emissions – the emissions we cannot fully eliminate, such as from agriculture, wastewater, and cement production

According to the Danish Council on Climate Change, achieving a 110% reduction by 2050 through a high-innovation pathway will require removing up to 9.1 million tons of CO_2 annually using DAC.

Other approaches—like afforestation, biochar, and bioenergy with carbon

capture and storage (BECCS)—also have potential, but they rely heavily on land use and biomass. These are increasingly scarce and contested resources. DAC, by contrast, does not compete for land or biomass, making it uniquely relevant in a carbon-constrained future.

Figure 1 illustrates the Danish Climate Council's assessment of how emissions could look in 2050 if the goal of a 110% reduction is to be achieved primarily through the development of new technologies. Afforestation, biochar, and BECCS all remove CO_2 from the atmosphere, but the majority of removals would need to come from Direct Air Capture (DAC), which alone would have to account for around 9 million tonnes of CO_2 removed in 2050 for the climate-positive target to be realized.



Translation of terms: Affald → Waste. Landbrug → Agriculture. Arealanvendelse → Land Use. Biokul → Biochar. Nettoudledning → Net Emissions. Industri → Industry. Skov → Forests

Despite its significant reduction potential, DAC is still a relatively untested and technologically immature solution. If the technology is to play a meaningful role by 2050, it is essential that we begin testing, adapting, and integrating it into a Danish context now.

What does success in 2050 require?

Removing CO_2 from the air demands energy, space, and - in some cases - water. That's why DAC must be planned in tandem with our wider renewable energy strategy. Encouragingly, DAC consumes significantly less electricity than other major technologies like Power-to-X, and even less than projected future demand from data centers.

DAC units themselves don't require much space, but they do need access to renewable power. This means they must be located where solar or wind energy is available - highlighting the need for smart, energy system-level integration.

Cost remains a major hurdle. Today, capturing one ton of CO_2 via DAC can cost up to 4,000 DKK. This depends on the technology type, energy source, and site location. Systems that require high-temperature heat are typically more expensive, as heat is a costly resource.

In the longer term, costs can drop as technologies mature and scale. Modelling from Aalborg University suggests prices could fall to 2,400–2,600 DKK per ton, assuming large-scale deployment.

Although it is still expensive, DAC can offer some additional benefits. Some technologies are capable of producing water as a byproduct. Others can help support the electricity grid by adjusting their power consumption depending on whether there is an excess or shortage of electricity in the system. This contributes to grid balancing - especially important when electricity comes from variable sources like solar and wind. Moreover, the captured CO_2 can be used in new and innovative ways. For example, it can be used in the production of green fuels, plastics, building materials, and other products that are currently made using fossil-based inputs.

The key unknowns – and what to do about them

DAC is particularly relevant for hard-to-abate sectors and for cleaning up legacy emissions. But it's still early days. We lack large-scale, real-world experience in Denmark.

There are three key uncertainties:

Energy system integration
We still don't know how DAC will perform at scale under Danish conditions or how best to embed it into the national energy system.

Energy demand
DAC needs significant energy input. Its climate benefit depends on access to low-carbon electricity or surplus heat. Without this, the net climate gain may be lost.

Cost
High costs remain a barrier. But as technologies develop and expand, prices are expected to fall. DAC facilities may also deliver co-benefits—such as water recovery, grid services, or carbon-based products—that increase their value.

These uncertainties are not barriers. They are design challenges. But addressing them requires stable frameworks, cross-sectoral collaboration, and a long-term plan for scaling up.

Although DAC is intended to address the emissions we cannot eliminate through electrification and efficiency alone, it is crucial that we begin further developing and testing the technology now—so it will be ready by 2050.

If we succeed, we can also achieve a negative emissions target—avoiding overreliance on biomass while ensuring that we genuinely remove more CO_2 than we emit.

Learn More

See Aalborg University's 2024 explainer: "Direct Air Capture in Denmark – A Guide to Achieving Negative Emissions by 2050"

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About INNO-CCUS

INNO-CCUS is a Danish, mission-driven partnership that has, since 2022, worked to promote technologies for carbon capture, utilization, and storage (CCUS). The partnership brings together more than 80 actors from industry, universities, and public institutions with the shared goal of accelerating the green transition and helping Denmark reach its climate targets.

INNO-CCUS is one of four strategic partnerships established to develop solutions to key climate challenges. With a total grant of DKK 350 million, funded by Innovation Fund Denmark and NextGenerationEU, INNO-CCUS focuses on maturing and scaling CCUS technologies that are essential to achieving both climate neutrality and climate-positive outcomes in Denmark.

The partnership supports research and innovation projects spanning the entire CCUS value chain, divided into five thematic tracks:

- Chemical CO_2 capture
- Biological CO_2 capture and storage
- Geological CO_2 storage
- CO_2 utilization
- Society and systems analysis