CLEAN AIR TASK FORCE

CARBON LIMITS

The — gap between carbon capture and storage ambitions and available funding

In light of all the carbon capture and storage projects announced throughout Europe, will there be enough public funding to match these ambitions?

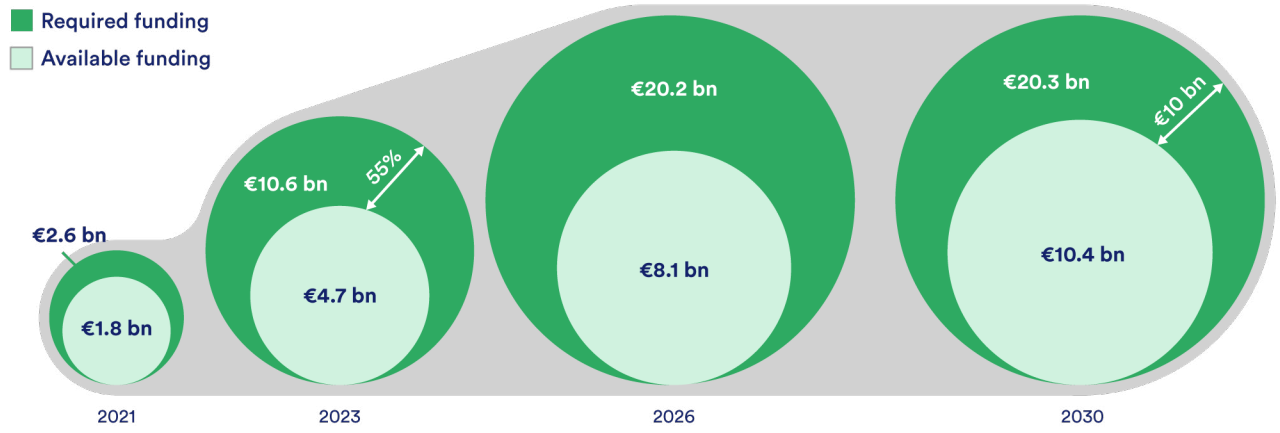
As highlighted by the most recent Intergovernmental Panel on Climate Change report[1], carbon capture and storage is an essential tool to reduce greenhouse gas emissions, as well as for achieving CO_2 removal through the storage of CO_2 obtained from direct air capture or from bio-energy emissions. Throughout Europe, over 50 CO_2 capture and storage projects have been announced so far. Despite some long-standing projects, such as the Sleipner and Snøhvit projects in Norway, carbon capture and storage has yet to be widely deployed and its cost varies significantly across different industries and regions. These projects will require adequate revenue streams and a positive business case to materialise.

There are several different incentive mechanisms that can help drive the deployment of carbon capture and storage, such as the European Union Emission Trading System (EU ETS) which increases the cost of CO_2 emissions and therefore comparatively increase the profitability of less carbon-intensive plants, or other incentives which focus on helping companies support the costs of implementing the technology. Several public financial aids for carbon capture and storage – often as part of more general support packages for emissions reduction projects – have been announced both at a European level and nationally in countries with carbon capture ambitions. Notable sources of funding include the EU's Innovation Fund and Connecting Europe Facility, the Netherlands' SDE++ scheme, and targeted funding for CO_2 infrastructure in the UK and Norway. Will existing funding programmes be sufficient to match the European aspirations for this technology? That is the question this analysis has set out to answer, relying on CATF's European project database and on a review of European and national subsidies and funding mechanisms which could potentially support carbon capture and storage projects.

[1] IPCC report, 2021 – Chapter 4 (4.6.3.2 Climate response to mitigation by Carbon Dioxide Removal (CDR))

Will public funding be sufficient to match European carbon capture and storage ambitions?

Figure 1: Estimate of cumulative net present value of projects and available funding for carbon capture and storage in Europe



Reference: CATF European carbon capture and storage project database, Carbon Limits analysis (see list of references below for individual funds included in the analysis)

Based on the methodology detailed below, the analysis shows that announced European and national funding for carbon capture and storage will not be sufficient to support those projects which are unable to recover their capital and operational costs by relying on the carbon price alone.

From the start of the analysis, there is already a deficit of public funding to cover the non-recoverable costs of those projects planning to start by 2024, which were considered as beginning to incur costs in 2021 for this analysis. This gap deepens rapidly with a growing number of projects which do not recover costs through carbon pricing and would require additional funding. By 2023, 55% of the excess costs of carbon capture and storage projects are not covered by the announced public funding.

Up to 2026, the gap deepens further due to the large number of new projects and scaling up of existing projects which will need to secure funding for a start date planned in 2030. Even with the carbon price estimated to increase to 93 €/t CO_2 in 2030, many of these projects will not be able to recover their initial investment and operational costs and will still require some additional funding to make up for this shortfall. By the end of the decade, there will be a total shortfall of €10 billion.

There remain many variable parameters moving forward, such as the importance of the learning curve for carbon capture and storage costs, the evolution of the carbon price, the industrial landscape in Europe and future environmental policies, and the development of storage sites. These can influence both the need for and the availability of funding.

In order to match the carbon capture and storage ambitions announced by companies and by some countries as part of their national climate objectives, additional funding to what has currently been announced will be required – particularly for sectors with high capture costs and if transport and storage costs remain high. Moreover, implementation of full-scale operational projects and increased competition between capture technology and transport and storage providers are essential to drive down the costs and make carbon capture and storage more accessible to investing companies.

Early movers take the most risk but contribute to the strongest learning effects and should therefore be encouraged with appropriate funding mechanisms. This should be taken into account when establishing carbon capture and storage deployment plans at country levels, to provide the correct support and prioritise the most promising emissions reduction opportunities.

More importantly, as most of the funds considered above apply to multiple emissions reduction solutions, funding which specifically targets carbon capture and storage needs to be further developed, along with other policy mechanisms that encourage the uptake of large-scale decarbonization projects through CO_2 capture, positively impacting their profitability and providing companies with the long-term outlook necessary for the decision-making process.

The need for public funding reduces over time as the increasing cost of emitting CO_2 and declining technology costs allow projects to increase their return on investment. The most critical need for support is in the short run, in order to kickstart the deployment of the technology, develop enabling infrastructure, and ensure broader adoption by the industrial sector.

In addition, the analysis shows that there might be discrepancies between the time at which the funding is allocated and the time at which projects would require commitments to support their investments. The analysis presents an even distribution of funds over the years, whilst projects may require important upfront investments to be committed within a short time span which could prove to be a challenge for the EU and individual countries. Many entities have announced a start or expansion of carbon capture and storage activities in 2030 and therefore, the need for funding commitments might arise for multiple projects simultaneously. Very few projects have been announced to start operations and a surplus of public funding for those years can be expected, if distributed evenly over time.

Are some countries better off than others?

As capture and storage might not take place in the same country, the analysis considered the total funding announced at the European and national level, without making the distinction between countries. Individually, some countries have already started providing incentives to decarbonisation and more specifically to carbon capture and storage in line with their ambitions. The Netherlands' annual SDE++ scheme awards 12 or 15-year contracts to cover the additional costs of decarbonisation projects (including carbon capture and storage) and has committed funding to four CO_2 capture projects and associated infrastructure in the Port of Rotterdam. In the UK, the Carbon Capture and Storage Infrastructure Fund (CIF) will support capital investment in CO_2 transport and storage infrastructure and industrial carbon capture. Norway is also an early mover on carbon capture and storage and currently home to the only large-scale projects in Europe (Sleipner and Snøhvit). Both projects have been implemented because the oil and gas company Equinor was subject to the Norwegian carbon tax for offshore production[2]. In addition, the Norwegian government has recently committed to allocating funds to two capture projects (a cement and waste-to-energy plant) as well as to a large-scale transport and storage project (Northern Lights). The projects have received reliable support for the full project cycle, from early studies to implementation[3]. The funding, combined with the reduction in CO_2 emissions expenses for the two capture projects, should cover project costs and kickstart large-scale carbon capture and storage in Norway and Northern Europe by providing pioneer facilities and transport and storage infrastructure.

As projects develop, governments might decide to direct support to individual projects, which could help close the potential funding gap in the future. In addition, as technology costs and carbon prices evolve, companies and investors might see increased financial opportunities in carbon capture and storage, along with the environmental benefits it provides.

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[2] Teknisk Ukeblad reported in September 2021 that up until now thanks to their CO_2 storage projects, Equinor saved around 7 billion NOK in tax and quota (approximately: 700 million EUR). Source: https://www.tu.no/artikler/co-lagring-pa-sleipner-equinor-har-spart-syv-milliarder-i-avgifter-og-kvoter/513463?utm_source=newsletter-tudaily&utm_medium=email&utm_campaign=newsletter-2021-09-20

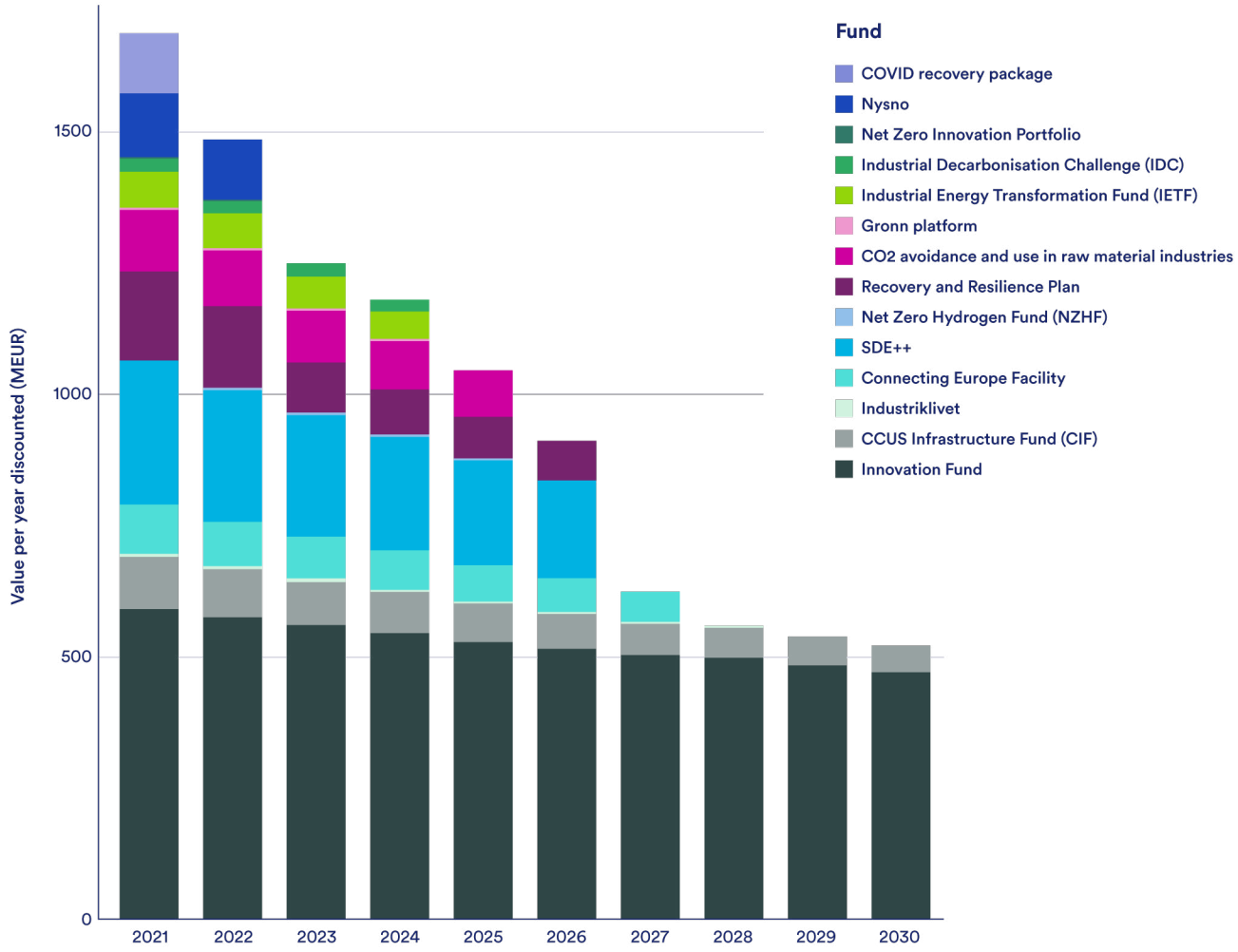
[3] The Norwegian government announced in 2020 that they would fund 16.8 BNOK (around 1.6 BEUR) of the 25.1 BNOK (around 2.4 BEUR) necessary for the completion of the first full scale carbon capture and storage project in Norway. Additional funding is required for Fortum Oslo Varme's waste-to-energy plant to fulfill their funding requirement for the project.

What stands behind this analysis?

Available funding

Data was collected on European and national funding available to support the deployment of carbon capture and storage projects. Some funds apply more generally to several types of emission reduction projects. Where available, data was collected on the share of the fund allocated to carbon capture and storage. If no further information was available on this, assumptions were made based on the number of topics covered by the fund. Data was also collected on the start and end date of all the funding mechanisms and the available funds were distributed over the lifetime of the fund. The discounted value of future years of funding was then considered, to align with the Net Present Value (NPV) calculated for projects. A discount rate of 8% was considered and funding is presented in EUR-2021 in the analysis. For the Innovation Fund, which is a big contributor to carbon capture projects throughout Europe, its exact value is linked to the EUA (European Union Allowances) prices, which are expected to increase over time. For this support mechanism, the assumptions on carbon prices listed below were considered to determine the annual value available from each fund. Assumptions were made on the potential end date of the different funding mechanisms if this information was unavailable.

Figure 2: Availability of funds considered over time



Source: Carbon Limits analysis

Required funding

General capture, transport and storage costs were estimated per ton of CO_2 and the latest EUA CO_2 price was considered to determine the total cost of carbon capture and storage. Assumptions were then made on the potential evolution of the cost based on the learning effects, the increase in CO_2 capture volumes and the expected evolution of the CO_2 price in Europe.

As strong variations per sector exist, high and low cost-scenarios were considered, based on an analysis published by the IEA for current capture costs (€50-100/ton CO_2)[4] and the costs publicly announced by the Northern Lights project for transport and storage (€30-55/ton CO_2), including capital and operational expenditures (capex and opex) for both. High, low, and medium costs of capture, along with an average transport and storage cost, were considered and were allocated to projects, based on the industrial sector.

Table 1: High, medium, and low assumptions for the cost of carbon capture and storage (CCS) considered for the two scenarios (including capture, transport, and storage)

Cost of CCS	Sectors	2021	2030
Low estimate	Hydrogen	€93/tCO_2	€48/tCO_2
Medium estimate	Hubs/clusters/mixed sources, cement	€118/tCO_2	€61/tCO_2
High estimate	Waste-to-energy, iron and steel, refinery, power	€143/tCO_2	€74/tCO_2
Carbon Price		€60/tCO_2	€93/tCO_2

References: CL assumptions based on IEA, discussion with storage projects and https://www.spglobal.com/platts/en/market-insights/latest-news/coal/120320-analysts-see-eu-carbon-prices-at-eur56-eur89mt-by-2030

All upcoming carbon capture projects throughout Europe were identified, relying on the CATF European carbon capture and storage database. Additional data was collected for those with sufficiently detailed timelines and volumes. Projects at a very early stage of development and/or which have not yet published clear deployment plans were excluded from the analysis.

For each capture project, given that expected capture volumes surpass expected storage capacity (see white paper *Gap between carbon storage development and capture demand*), the net present value of capture, transport and storage costs were calculated based on announced capture volume and unit costs. Costs for the year of project start were considered. Initial investment (capex) is assumed to occur 3 years before project start and operating expenses (opex) begin in the year of project start and last for the duration of the project (20 years). In addition, the price of CO_2 was considered as a revenue for capture projects. The price of CO_2 increases by 5% each year until 2040, after which it is assumed constant.

Required funding, as represented on the graph, is considered as the net present value (NPV) of the project, reflecting the investment which is not recovered by carbon price. Projects with a positive NPV, meaning they are directly profitable projects, were excluded from the analysis as their returns should allow them to recover initial investments.

[4] Carbon Limits assumption based on IEA, *Is carbon capture too expensive?*, February 2021, https://www.iea.org/commentaries/is-carbon-capture-too-expensive

Funding considered for this analysis

Fund	Country	Reference
Innovation Fund	All	https://ec.europa.eu/clima/policies/innovation-fund_en
Connecting Europe Facility	All	https://cinea.ec.europa.eu/news/connecting-europe-facility-2021-2027-adopted-2021-07-20_en
Recovery and resilience plan	Belgium	https://dermine.belgium.be/sites/default/files/articles/FR%20-%20Plan%20national%20pour%20la%20reprise%20et%20la%20re%CC%81silience.pdf
Recovery and resilience plan	Denmark	https://fm.dk/media/18776/factsheet-on-the-danish-recovery-and-resilience-plan-in-english.pdf
Recovery and resilience plan	Finland	https://julkaisut.valtioneuvosto.fi/bitstream/handle/10024/163363/VN_2021_69.pdf?sequence=1&isAllowed=y
CO_2 avoidance and use in raw materials	Germany	https://www.argusmedia.com/en/news/2184819-germany-launches-ccus-support
Recovery and resilience plan	Greece	https://www.worldoil.com/news/2021/2/25/energean-proposes-500mm-carbon-storage-facility-in-northern-greece
SDE ++	Netherlands	https://english.rvo.nl/subsidies-programmes/sde
Industriklivet	Sweden	http://www.energimyndigheten.se/forskning-och-innovation/forskning/omraden-for-forskning/industri/industriklivet/
Net zero innovation portfolio	UK	https://www.gov.uk/government/collections/net-zero-innovation-portfolio
Industrial Decarbonisation challenge	UK	https://www.ukri.org/our-work/our-main-funds/industrial-strategy-challenge-fund/clean-growth/industrial-decarbonisation-challenge/
CCUS Infrastructure Fund (CIF)	UK	https://www.gov.uk/government/publications/design-of-the-carbon-capture-and-storage-ccs-infrastructure-fund
Industrial Energy Transformation Fund	UK	https://www.gov.uk/government/collections/industrial-energy-transformation-fund
Covid recovery package	UK	PM: A New Deal for Britain - GOV.UK (www.gov.uk)

Note: only funds with sufficient time and value data were considered in this analysis. Funds announced after October 2021 were not considered.