CLEAN AIR TASK FORCE

CARBON LIMITS

The — gap between funding for carbon capture and storage projects and other emissions reduction options

How does funding allocated to carbon capture and storage projects compare to funding for renewable technologies?

In June 2021, the EU adopted the European Climate Law[1] which sets a target for Europe to become climate neutral by 2050. The law also sets an intermediate target of reducing net greenhouse gas emissions by at least 55% by 2030, compared to 1990 levels. **These targets are achievable only through deliberate implementation of emissions reduction technologies.**

Renewable power generation has been a major focus of EU efforts to deploy low-carbon technologies, with wind and solar power contributing 13.6% and 5.2% of total generation in the EU in 2020[2]. Carbon capture and storage is also an essential technology to decarbonise several industrial sectors, including cement, steel, and chemicals, where it allows for effective emissions reduction alongside other green transition technologies, such as process electrification powered by renewable electricity. Both carbon capture and storage and renewable electricity generation can help different sectors tackle their emissions and are therefore complementary approaches to decarbonisation.

Private investment alone is typically not sufficient to drive the initial deployment of low-carbon technologies; public financial support and regulatory incentives are also required. This white paper compares some of the public funding allocated to carbon capture and storage and the main renewable energy technologies: onshore and offshore wind, solar and ocean energy (wave and tidal), on a basis of euros spent per tonne of CO_2 avoided. The carbon capture and storage projects considered in this analysis are not yet operational and, where not disclaimed, assumptions for tonnes of CO_2 avoided were taken based on the announced volumes.

[1] Regulation (EU) 2021/1119 of the European Parliament and of the Council establishing the framework for achieving climate neutrality and amending Regulations (EC) No 401/2009 and (EU) 2018/1999 ('European Climate Law'), June 2021.

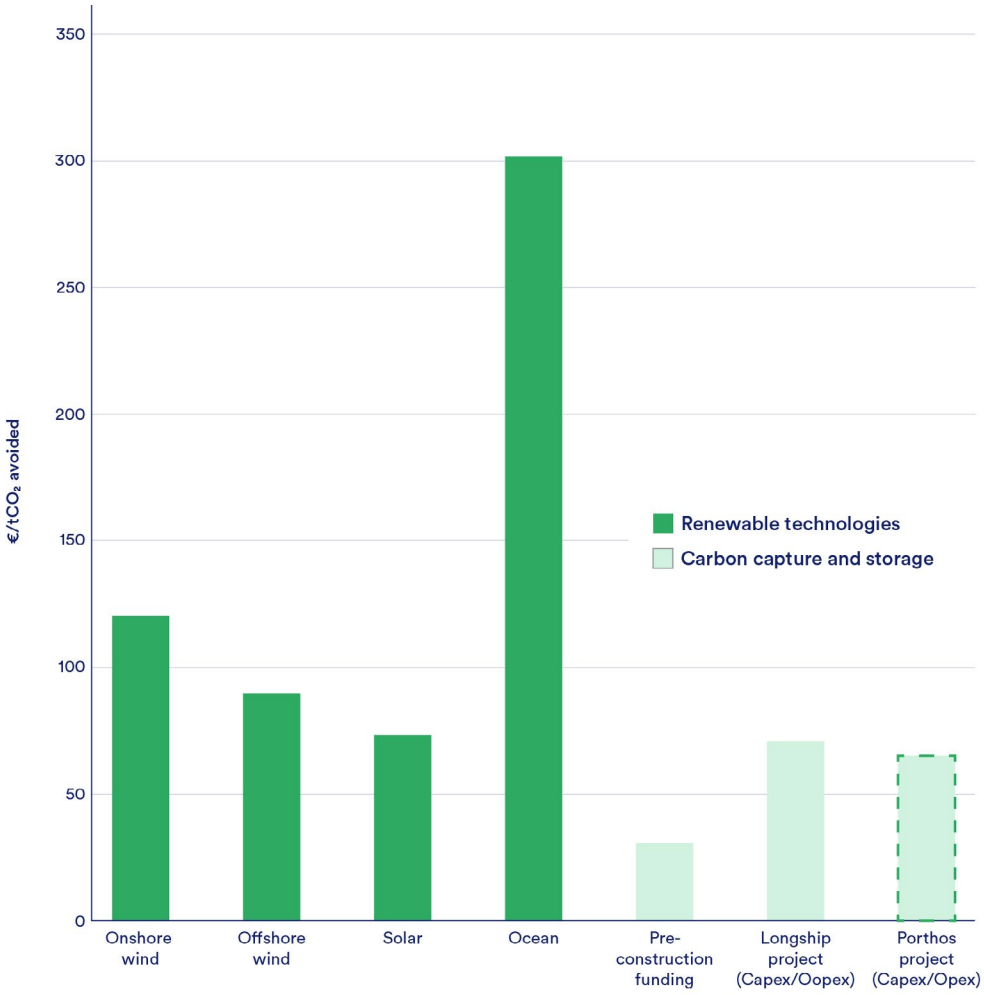
[2] Eurostat, Energy from renewable sources, https://ec.europa.eu/eurostat/web/energy/data/shares

Funding considered in this analysis is limited to the major grant-based support schemes in Europe from 2012 to 2021, for which the CO_2 avoidance potential of targeted projects can be quantified. Funding in the form of power-price mechanisms (for example feed-in tariffs, feed-in premiums, contracts for differences etc.) were not considered in the analysis, although they represent a major form of support for renewable technologies.

Hydropower and geothermal technologies were excluded from the analysis as the former is already a mature technology and the latter currently does not receive substantial funding allocations. Bioenergy was not included in the analysis as the funds considered did not reflect a representative selection of bioenergy projects.

How much funding is allocated to carbon capture and storage compared to other emissions reduction technologies?

Figure 1: How funding is concentrated across different emissions reduction technologies compared to effectively reduced emissions (€/t CO_2 avoided)



Reference: Carbon Limits analysis (see list of references below for individual funds considered for the analysis)

Note: the dotted line around the Porthos project reflects the uncertainty in funding from the Dutch SDE++, which is dependent on the difference between carbon price and the cost of carbon capture and storage.

Figure 1 illustrates the relative levels of funding awarded to selected renewable technologies (wind, solar, ocean technologies) compared to the funding allocated to carbon capture and storage technologies, including:

- pre-construction activities, such as pre-FEED, FEED studies, test/pilot facilities
- two commercial-scale carbon capture and storage projects in Europe that have currently received significant national funding commitments for their capital and operational expenses:
  - Porthos (Netherlands – awaiting a final investment decision)
  - Longship (Norway – under construction)

Funding considered in this analysis includes major EU schemes such as the NER 300, the European Energy Program for Recovery (EEPR), and the European Fund for Strategic Investments, as well as national-level support for carbon capture and storage such as the UK's Industrial Decarbonisation Challenge (IDC) and the Netherlands' SDE++ (see below). Depending on the type of mechanism considered, significant differences in the funding allocated per tonne of CO_2 avoided were calculated. However, the average value reflects an overall funding allocation from various relevant mechanisms. The total funding considered for this analysis amounted to €2.4 billion across renewable funding and €4.7 billion to carbon capture and storage projects.

Figure 1 shows that funding per tonne of CO_2 avoided among renewables is distributed unevenly, with ocean technologies receiving higher funding as they are not as advanced on the learning curve as the other technologies. Few renewable projects relying on ocean technologies have been deployed and, as it is still an emerging technology, it has comparatively received substantial funding on a per tonne of CO_2 basis. However, in absolute terms, it represents less than 4% of the total renewable energy funding considered in this analysis.

Overall, funding per tonne avoided for Porthos and Longship is 35-50% lower than that of wind and solar technologies. On this basis, carbon capture and storage pre-construction funding is over 70% lower than any other emission reduction technology.

It is important to note that most of the grants awarded to the Porthos project come from the Dutch SDE++ scheme. This funding is aimed at bridging the gap between the current rates for CO_2 emission allowances (ETS) and the costs associated with decarbonisation activities such as carbon capture and storage. The majority of the funding that has been allocated to the Porthos project is a budget reservation (€2.1 billion), constituting the maximum amount that may be paid to the project over the term of 15 years. The actual total funding might be significantly lower since the price of CO_2 under the ETS is expected to rise further in the coming years. That means that the Porthos project might require much less funding than the level depicted in Figure 1.

Norway and the Netherlands are currently the most advanced countries in Europe in terms of dedicated governmental support for carbon capture and storage projects. The UK has also established a £1 billion CCUS Infrastructure Fund and is developing revenue streams for carbon capture projects based on a contracts for difference mechanism. At the EU level, the Innovation Fund will provide capital and operational support to low-carbon technology demonstrations. Out of seven projects awarded funding under the first call (€1.1 billion) for large-scale projects, four were carbon capture related. The level of funding together with the greenhouse gas emissions avoidance per project were recently made public[3]. On average, the three projects based only on carbon capture and storage[4] (Kairos@C, K6 Program, and BECCS Stockholm) should receive a maximum of 23 €/tCO_2 avoided. These projects might also be supported by national funding as long as State aid rules are followed.

[3] European Commission press release, April 1st 2022, Commission awards over €1 billion to innovative projects for the EU climate transition, https://ec.europa.eu/commission/presscorner/detail/en/IP_22_2163

[4] One of the four carbon capture-related projects (SHARC) also has a green hydrogen component.

Funding from other initiatives

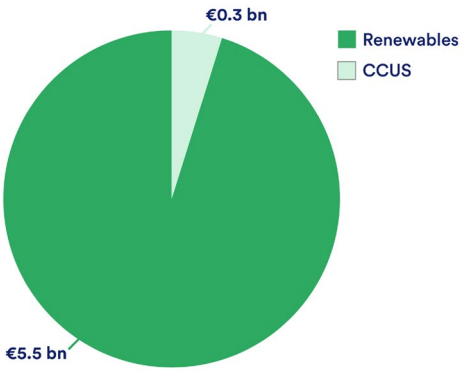
Carbon capture and storage projects have historically been allocated significantly less funding than renewable energy projects. The first EU funding scheme (NER 300) – aiming to allocate support to emissions reduction projects including carbon capture and storage – awarded €1.2 billion in 2012 to 23 renewable energy projects. None of the carbon capture projects that applied for NER 300 were confirmed by the Member States due to remaining funding gaps or insufficient project maturity.

In the second allocation round of the NER 300 in 2014, the European Commission awarded €1 billion to 19 renewable energy projects and to a single carbon capture and storage project in the UK, which was eventually cancelled due to the withdrawal of additional funding from the UK government.

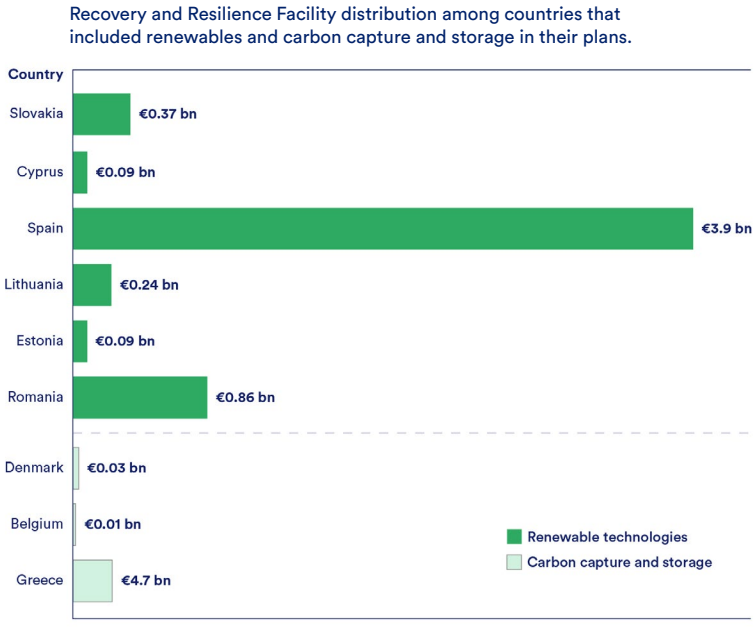
Renewables continue to be the predominant recipients of state energy funding schemes. According to the European Commission, more than 40% of the total energy subsidies in the European Union were assigned to renewable sources in the past few years, amounting to €71 billion in 2020[5]. Most of these subsidies take the form of power pricing mechanisms such as contracts for difference or feed-in tariffs. The latter amounted to €53 billion in 2019 and, by rough estimates, to €51 billion in 2020. The UK's contract for difference scheme was an important contributor of public funding for renewables, providing €831 million, for the first allocation round in 2015.

In February 2021, the European Commission announced the Recovery and Resilience Facility (the Facility) program which will make €723.8 billion available to support reforms and investments undertaken by Member States. One of the focal points of the Facility is the green transition in EU countries. It includes clean technologies, renewables, energy efficiency and sustainable transport. Figure 2 illustrates the distribution of funds dedicated to emissions reduction technologies under the Facility. Member States that included carbon capture and storage and renewables in their clean transition activities dedicate considerably less funding to the former.

Figure 2: Distribution of funding between carbon capture and storage and renewable technologies in the EU Recovery and Resilience Facility



Reference: Carbon Limits analysis of the Recovery and Resilience Facility initiative[6]



[5] European Commission, *Annex to the Report from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions - 2021 report on the State of the Energy Union - Contribution to the European Green Deal and the Union's recovery*, 26 October 2021

[6] European Commission, *Recovery and Resilience Facility*, https://ec.europa.eu/info/business-economy-euro/recovery-coronavirus/recovery-and-resilience-facility_en

Addressing the imbalance

A number of factors can explain the relatively poor funding for carbon capture and storage, with the relatively high upfront costs of large-scale infrastructure and capture projects being one of the main reasons. In contrast, renewable energy can often be deployed in a more modular fashion, with more incremental carbon abatement. Until recently, climate policy has also tended to focus on decarbonising the power sector. As most industrial emitters are not fully exposed to carbon pricing under the ETS, there is little near-term incentive to implement low-carbon technologies such as carbon capture and storage in many sectors. This means that one-off grant funding for project capital costs is not supported by an ongoing commercial incentive over the project lifetime.

The cost of carbon capture and storage cost is highly dependent on the capture component of the value chain. For industrial processes with highly concentrated CO_2 streams (such as ethanol production, natural gas processing, and hydrogen production) the cost of CO_2 capture will be in the range 13-22 €/tCO_2 and for processes with lower CO_2 concentration in the flue gas (e.g., cement production, power generation) the cost of CO_2 capture could be 35-105 €/tCO_2[7]. Different levels of funding will therefore be required for projects associated with different industries and some may be more challenging to decarbonise.

The positive progress of Norway's Longship project indicates that the levels of public funding to support these technologies could be comparable to or even lower than funding received by wind and solar projects in the power sector. Just as the renewable energy industry has received significant additional funding to supplement the carbon price signal during its early years of development, the emerging carbon capture and storage industry would clearly benefit from equivalent levels of support to accelerate deployment.

2020 and 2021 have been breakthrough years for carbon capture and storage technology in terms of new funding mechanisms. The European Union, the United Kingdom, Norway, and the Netherlands announced significant incentives to promote investment in the technology. Crucially, many of these incentives provide support across all project development phases: pre-FEED and FEED studies, capital and operational expenses. Nevertheless, more widespread implementation of such policies is required, as carbon capture and storage will play a key role in achieving carbon neutrality by 2050.

What stands behind this analysis?

Funding awarded to the renewable technologies

Data on EU and Member States funding distributed to commercial solar, ocean (wave and tidal), onshore and offshore wind projects were collected. The scope of the analysis did not include R&D funding. Information on the projects' power/capacity, the value of funds allocated, and the allocation year were taken into account for the analysis.

Total energy produced by the project was calculated based on the load factor for different renewable technologies and an assumed project lifetime of 15 years for capital investments and 1 year for payments after the projects start up (e.g. contracts for differences).

Total energy produced = Capacity (MW) x Load Factor x Project Lifetime

Based on the total energy produced, emissions from the grid and the renewables were calculated. Emissions from the grid considered lifecycle grid emission factor according to the country and the year the funding was allocated to the project:

CO_2 ref scenario = Total energy produced x EF grid

[7] IEA, *Energy Technology Perspectives 2020 – Special report on Carbon Capture Utilisation and Storage – CCUS in clean energy transition*, 2020, https://www.iea.org/reports/ccus-in-clean-energy-transitions

Emissions from the renewables were calculated considering lifecycle emissions for different renewables.

$$CO_2 \text{ renewables} = \text{Total energy produced} \times \text{Lifecycle emissions}$$

The difference between lifecycle emissions from the grid and emissions from renewables results in the value of CO_2 avoided.

$$CO_2 \text{ avoided} = CO_2 \text{ ref scenario} - CO_2 \text{ renewables}$$

The cost of CO_2 avoided was calculated considering the funds allocated to the projects and the amount of CO_2 avoided.

$$€/tCO_2 = \text{Project funding} / CO_2 \text{ avoided}$$

Funding awarded to carbon capture and storage projects

Funding distribution per tCO_2 was calculated based on the total value of the state aid; declared amount of CO_2 to be captured and stored annually and the duration of the project. To accommodate for projects' lifecycle emissions 10%[8] decrease was included on the declared amount of CO_2 to be captured and stored annually.

$$CO_2 \text{ avoided } (€/tCO_2) = \text{Project funding} / (\text{Annual storage capacity} \times 110\% \times \text{Project duration})$$

Funding schemes considered in this analysis

Fund	Country	Reference	Comment
NER 300 (first award decision)	All	https://ec.europa.eu/commission/presscorner/detail/en/MEMO_12_999	Data used in the analysis
NER 300 (second award decision)	All	https://ec.europa.eu/commission/presscorner/detail/en/MEMO_14_465	Data used in the analysis
European Fund for Strategic Investments	All	https://www.eib.org/en/projects/pipelines/all/20160002	Data used in the analysis
European Energy Programme for Recovery	All	https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal/finance-and-green-deal/just-transition-mechanism_en	Data used in the analysis
SDE++	Netherlands	https://english.rvo.nl/subsidies-programmes/sde	Data used in the analysis
Industrial Decarbonisation Challenge	UK	https://www.ukri.org/our-work/our-main-funds/industrial-strategy-challenge-fund/clean-growth/industrial-decarbonisation-challenge/	Data used in the analysis
Longship funding	Norway	https://www.regjeringen.no/en/historical-archive/solbergs-government/Ministries/oed/press-releases/2020/funding-for-longship-and-northern-lights-approved/id2791729/	Data used in the analysis

[8] https://ccsnorway.com/carbon-footprint/#Gassnovas_footprint_calculator

Fund	Country	Reference	Comment
Porthos funding	Netherlands	https://www.porthosco2.nl/en/faq/will-porthos-receive-subsidies-for-this-project/	Data used in the analysis
Test Center Mongstad funding	Norway	https://tcmda.com/about-tcm/	Data used in the analysis
The Danish Energy Agency funding	Denmark	https://www.carboncapturejournal.com/ViewNews.aspx?NewsID=4883	Data used in the analysis
Recovery and Resilience Facility	All	https://ec.europa.eu/info/business-economy-euro/recovery-coronavirus/recovery-and-resilience-facility_en	Was used to analyse funding distribution of that particular fund when it comes to renewables and carbon capture and storage (Figure 2).
Cohesion Fund	All	https://ec.europa.eu/regional_policy/en/2021_2027/	Was not used for the analysis as the fund will run from 2021 to 2027. There is no information on funding allocation as of November 2021.
Horizon 2020 and Horizon Europe	All	https://ec.europa.eu/programmes/horizon2020/en/area/energy	Was not used in the analysis due to its R&D nature.
LIFE: Clean Energy Transition	All	https://cinea.ec.europa.eu/life/clean-energy-transition_en	Was not used in the analysis as it does not support renewable or carbon capture and storage projects per se.
EU State Aid	All	https://ec.europa.eu/competition-policy/state-aid_en	The European Commission approves various scheme to support emission reduction technologies under the State Aid rules with the aim of helping EU countries to achieve their emission reduction targets. It is a substantial source of funding to renewable energy projects. But at the moment in many cases the funding distribution between the technologies approved under the State Aid rules is unclear.
Just Transition Fund	All	https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal/finance-and-green-deal/just-transition-mechanism_en	New funding scheme. There is no information on funding allocation as of November 2021.
Connecting Europe Facility	All	https://cinea.ec.europa.eu/news/connecting-europe-facility-2021-2027-adopted-2021-07-20_en	No information on projects' capacity is available.
Innovation Fund	All	https://ec.europa.eu/clima/policies/innovation-fund_en https://ec.europa.eu/clima/eu-action/funding-climate-action/innovation-fund/large-scale-projects_en	Three carbon capture and storage projects and one CCS and green hydrogen project were selected in the Round 1. The funding distribution was published on April 1st 2022.
Net zero innovation portfolio	UK	https://www.gov.uk/government/collections/net-zero-innovation-portfolio	Was not used in the analysis due to its R&D nature.
Industrial Energy Transformation Fund	UK	https://www.gov.uk/government/collections/industrial-energy-transformation-fund	New funding scheme. There is no information on funding allocation as of November 2021.