

Carbon capture and storage: costs, opportunity costs, economic viability and social returns

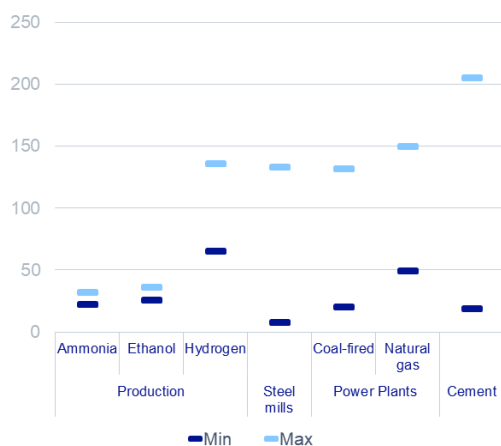
Carbon capture and storage (CCS) involves varied technologies and storage methods, making average costs hard to generalize. Still, with proper incentives and scale, costs are expected to decline. Additionally, as the opportunity cost — that is, the cost of emitting — rises, many CCS options could achieve positive economic returns sooner than expected. It is also worth noting that societal returns would be even higher if the full social cost of carbon emissions were taken into account, given that CCS is the most cost-effective way to decarbonize hard-to-abate sectors.

There is no single cost for CCS. The cost of capturing and storing CO₂ varies widely depending on the technology, location, application, and scale. In general, capture cost dominates the total cost – especially for dilute CO₂ streams – while transport and storage add a smaller but still significant amount.

Capture technology and sector application greatly influence cost ranges. Dilute, high-volume sources (power, cement) tend toward the upper end, whereas processes that inherently produce concentrated CO₂ (ammonia, ethanol, gas processing) are much cheaper. Indeed, capture can account for up to ~75% of total CCS cost in applications like power, cement, or steel where CO₂ separation from flue gas is energy-intensive. By contrast, when CO₂ separation is part of the normal process (as in natural gas processing or ammonia synthesis), CCS costs are much lower overall (**Figure 1**).

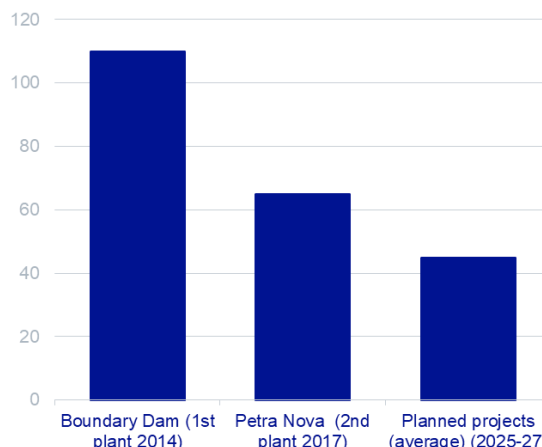
Transport and storage costs add further variability depending on CO₂ volume, distance, and geology. In regions with accessible geologic storage and pipeline infrastructure (e.g. onshore United States), transport by pipeline might cost only \$2–14 per ton for moderate distances, and storage (in saline aquifers or depleted oil/gas fields) often costs <\$10 per ton. By contrast, in regions requiring offshore CO₂ transport or complex storage (e.g. under the North Sea in Europe), transport & storage can be substantially higher, especially for early projects. Thus, **economies of scale and shared infrastructure are critical**.

FIGURE 1. ESTIMATES FOR COSTS OF CARBON CAPTURE¹ (USD/TON CO₂)



Source: BBVA Research from [Carbon Capture, Utilization, and Storage: Technologies and Costs in the U.S. Context | The Belfer Center for Science and International Affairs](#)

FIGURE 2. COST OF CO₂ CAPTURE FROM LARGE-SCALE COAL-FIRED POWER PLANTS (USD/TON CO₂)



Source: BBVA Research from [Is carbon capture too expensive? – Analysis - IEA](#)

Cost evolution shaped by low “experience rates”. Unlike wind or solar power, which have seen dramatic cost declines over the last decade, from the analysis of CCS cost trends it follows **slower cost reductions**.² Some CCS technologies have been used since the 1970s in some industries, yet **persistent high costs** remain due to project-by-project customization, high energy requirements, and limited deployment experience. An analysis of historical “experience rates” found CCS costs have fallen only modestly especially compared to the rapid improvements in renewable energy technologies. The use of CCS in limited situations makes a “learning by doing” process difficult. That said, **recent evidence of cost improvements is emerging**: The IEA [reports](#) that the cost of CO₂ capture at power plants **fell 35% from the first large-scale CCS plant to the second**, thanks to technology learning and better integration (**Figure 2**).

Scale-up and replication are expected to drive costs down. Policy support and market scale are critical to realize cost reductions. The [IEA emphasizes](#) that many CCS applications are still at an early stage on the cost curve, and stronger climate policy (carbon pricing, R&D funding, deployment incentives) is needed to achieve the kinds of cost declines seen in renewables. In the meantime, targeted government support (grants, tax credits, carbon contracts for difference) can bridge the cost gap for first-mover projects.

CCUS, the challenge of economic profitability. Stronger carbon pricing policies decrease the cost of opportunity of CCS, but in general terms capturing carbon is not yet economically profitable — it costs more than emitting it into the atmosphere, even considering current levels of EU-ETS (**Figure 3**). However, there is broad consensus on the expected rise in EU-ETS prices, with estimates for 2030 ranging from **€90/tCO₂** in the most conservative scenario to

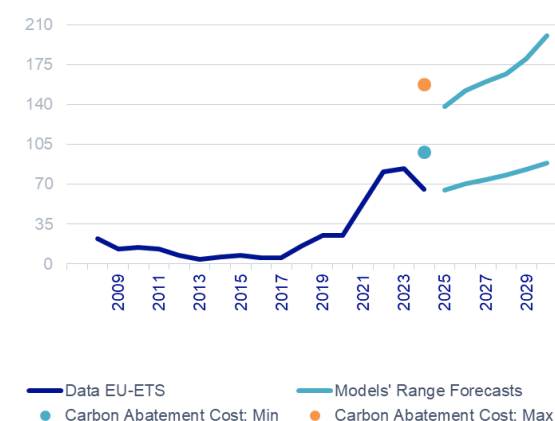
1: As there are limited CCUS facilities currently in operation, most estimates for CCUS costs come from modeling studies that apply a variety of assumptions. Reference: [Carbon Capture, Utilization, and Storage: Technologies and Costs in the U.S. Context | The Belfer Center for Science and International Affairs](#).

2: It is worth noting that the analysis of costs is predominantly based on modelling studies that employ various assumptions to forecast costs for theoretical facilities. Reference: [The Bottom Line: Why the cost of carbon capture and storage remains persistently high](#).

€200/tCO₂ in the highest one.³ This rise, together with the phase-out of free emission allowances, will strengthen incentives to adopt technologies that help reduce industrial emissions intensity — such as green hydrogen, electrification of thermal processes, or CCUS.

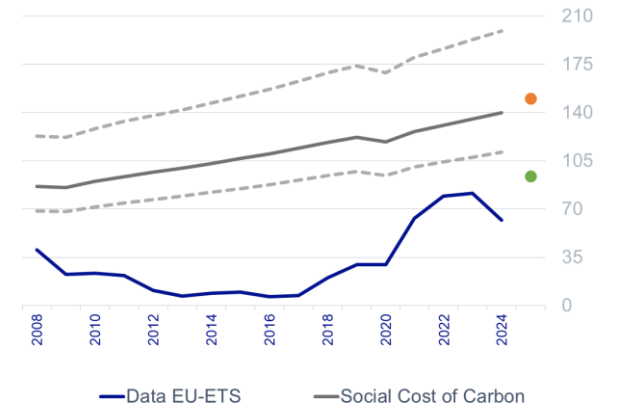
The social returns of carbon capture. While carbon capture and storage may not yet be economically profitable under current market conditions, its social returns should be at least “less negative” or “positive”. When the full social cost of carbon — that is, the monetary value of the damage caused by emitting one additional tonne of CO₂ — is considered, several sectors and capture technologies would generate net social benefits. Estimates by BBVA Research⁴ show that the social cost of carbon far exceeds current EU-ETS prices, indicating that markets continue substantially undervaluing the societal gains of emission net reductions. Consequently, even though CCS projects may appear costly from a “market” perspective it should be considered that: i) CCS is the cheapest way to decarbonize hard-to-abate emissions; ii) CCS would represent a socially efficient investment that mitigates long-term climate damage and supports the transition to an environmentally sustainable economy.

FIGURE 3. EU-ETS PRICE AND FORECASTS, AND ABATEMENT COSTS (€/TON CO₂)



Source: BBVA, BBVA Research and abatement costs from [Clean Air Task Force](#) for the Spanish economy

FIGURE 4. COST OF CO₂ CAPTURE FROM LARGE-SCALE COAL-FIRED POWER PLANTS (\$INT.2021/T CO₂)



Source: BBVA Research estimates of the social cost of carbon, based on [Global | Social Welfare and the Social Cost of Carbon | BBVA Research](#). Three trajectories are presented according to alternative discount rates (1.0%, 1.5%, and 2.0%)

References:

- [Is carbon capture too expensive? – Analysis - IEA](#)
- [Carbon Capture, Utilization, and Storage: Technologies and Costs in the U.S. Context | The Belfer Center for Science and International Affairs](#)
- [Executive summary – Direct Air Capture 2022 – Analysis - IEA](#)
- [U.S. Carbon Capture and Storage Report | PDF](#)

3: These figures may be biased downward if they do not account for forthcoming regulatory changes in the coming years, which could push prices even higher.

4: [Global | Social Welfare and the Social Cost of Carbon | BBVA Research](#).

- [Assessing the prospects, costs, and risks of carbon capture and storage implementation in Germany - ScienceDirect](#)
- [Total cost of carbon capture and storage implemented at a regional scale: northeastern and midwestern United States](#)
- [IEEFA Carbon capture and storage-Europe's climate gamble.pdf](#)
- [The Bottom Line: Why the cost of carbon capture and storage remains persistently high](#)
- [Global | Social Welfare and the Social Cost of Carbon | BBVA Research](#)

Highlights of the Week



Global

[Scaling up transition finance can support efforts to tackle emissions in key sectors and countries - News - IEA](#). A new report explores the landscape for transition finance today and how it could help channel capital towards hard-to-abate industries.

OECD

[OECD | New OECD long-run scenarios focus on the trade-off between carbon mitigation and climate damage](#). The reduction in global output associated with climate change, estimated to be approximately 1 3/4 per cent of global GDP today, rises to nearly 9% by 2100.

U.S.

[U.S. | U.S. Billion-Dollar Weather and Climate Disasters. Climate Central](#) maintains this comprehensive database tracking U.S. weather and climate disasters since 1980 where overall damages/costs reached or exceeded \$1 billion (including Consumer Price Index (CPI) adjustment to 2025).

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