FACTSHEET – CCUS IN POWER

BACKGROUND

The energy transition requires a massive increase in investments. According to the 'Net Zero Emissions by 2050' (NZE) scenario[1] of the International Energy Agency (IEA), which is the most referenced scenario with low or no overshoot and limited reliance on negative emissions technologies, yearly investments in the "clean" energy transition must more than double and reach US$4.2 trillion by 2030. Meanwhile investments in fossil fuels must decrease and any support to their expansion must be stopped immediately. However, the role of certain energy sources and technologies should be nuanced. Consideration is particularly required when development is uncertain or associated with damaging social, environmental and climate impacts or risks, or poses too great a threat to the 1.5°C objective and global biodiversity protection targets.

This document debates the potential of carbon capture utilisation and/or storage (CCUS) in the power sector transition. It is part of a series of factsheets that aim to guide the decisions of financial players wishing to contribute to a rapid and fair energy transition.

CCUS technology is used to mitigate carbon dioxide (CO2) emissions from the combustion of fossil fuels in power generation. Captured CO2 is either stored in underground cavities (27%) or valorised in industrial processes (73%) almost always for enhanced oil recovery (EOR),[2] which is used to increase oil field production.

KEY ELEMENTS – TECHNICAL PERFORMANCE

After several decades of experimentation, CCUS systems are still not fully understood, and no 'learning effect' seems to be occurring. The IEA states that "the history of CCUS has largely been one of unmet expectations."[3] The share of CCUS-related CO2 emission reductions in the power sector decreased by 40% in the IEA's NZE between 2021 and 2023, and "is compensated by more renewables and electrification".[4]

➢ Capture rate: theory versus reality

The IEA has said that "[h]igher CO2 capture rates will be essential for CCUS to play its role in the transition to a net zero energy system. CCUS-equipped power and industrial plants operating today are designed to capture around 90% of the CO2 from flue gas."[5]

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[1] IEA, World Energy Outlook, 2023.
[2] IEEFA, The carbon crux: Lessons learned, September 2022.
[3] IEA, Net Zero Roadmap: A Global Pathway to Keep the 1.5°C Goal in Reach, p.132, September 2023.
[4] IEA, Net Zero Roadmap: A Global Pathway to Keep the 1.5°C Goal in Reach, p.75, September 2023.
[5] IEA, CCUS overview, accessed in November 2023.

However, the two existing power plants currently equipped with CCUS – Boundary Dam 3 CCUS facility (Boundary Dam) in Canada and Petra Nova CCS facility (Petra Nova) in the USA – have displayed much lower performances. The former has never lived up to its capture target, finally lowering it from 90% to 65% in 2021,[6] while the latter's target is estimated to be around 65-70%.[7] In Petra Nova's case, the carbon capture system is powered by a carbon-emitting unabated gas turbine that further lowers its carbon capture efficiency to 55-58%.[8]

Moreover, due to the high costs of carbon capture, both projects do not store but valorise the captured CO2 through EOR. As such, the captured emissions must be balanced with the combustion emissions of the additional oil produced, something that is not accounted for in current capture rates.

➢ Increased energy consumption, lower efficiency

CCUS is estimated to consume 20-30% of the power generated in the associated system, resulting in a net power generation efficiency reduction of 6-12%.[9] This means a CCUS-equipped power plant requires more fossil fuels to be extracted, transported, and burned in order to generate the same amount of power.

This has both economic and environmental consequences:

- Increased electricity costs: as more fossil fuels are needed to produce the same amount of power, generation costs – driven by fuel costs – increase, reducing profit margins or leading to higher electricity prices for consumers.
- Fuel price volatility: as generation costs increase due to increased fuel consumption costs, the system becomes more sensitive to variations in fuel price, e.g. gas prices.
- Greenhouse gas (GHG) emissions: even if combustion emissions could be mitigated, the climate footprint of fossil fuels is additionally made up of methane leakages and CO2 emissions from extraction, transportation, and processing.[10] Increased fuel consumption therefore means increased methane and CO2 impacts for the same amount of power generated. This is incompatible with the decreases in methane emissions from fossil fuels and CO2 emissions from the energy sector in the NZE – 75% and 35% respectively by 2030.

KEY ELEMENT – ECONOMIC PERFORMANCE

➢ Major costs increase

It is hard to estimate the capital expenditure (CAPEX) associated with CCUS systems using either the Boundary Dam or Petra Nova business case. Indeed, additional costs vary from US$4,000 per kilowatt (kW) of installed capacity for Petra Nova and US$10,000 per kW for Boundary Dam.[11] While Petra Nova's capacity is twice that of Boundary Dam's, the scale effect alone cannot explain the difference: in absolute terms, Boundary Dam's retrofit cost US$150 million more than Petra Nova's. This clearly demonstrates the uncertainty surrounding CCUS costs.

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[6] IEEFA, Two years behind schedule, Boundary Dam 3 coal plant achieves goal of capturing 4 million metric tons of CO2, April 2021.
[7] IEEFA, The ill-fated Petra Nova CCS project: NRG Energy throws in the towel, October 2022.
[8] Ibid.
[9] National Energy Technology Laboratory, Bituminous Coal and Natural Gas to Electricity: >90% Capture Cases Technical Note, Shultz, p.3, 30 December 2021.
[10] Reclaim Finance, Methane: an imminent threat for climate and Human-caused methane emission must decrease, driven by cuts in the fossil fuel industry, 2023.
[11] IEEFA, CCS For Power Yet to Stack Up Against Alternatives, p.8, March 2023.

In comparison, an unabated coal plant is estimated to cost on average US$4,590 per kW of installed capacity, while an open cycle gas turbine (OCGT) and a combined cycle gas turbine (CCGT) cost US$810 and US$1,000 per kW respectively.[12]
Retrofitting (installing a CCUS system) therefore doubles to triples costs for coal plants and, assuming similar retrofit expenses to coal, increases the cost per kW by a factor of 4 to 12 for gas plants.

CCUS also raises operational expenditure (OPEX) due to the increased use of fuel and water – around 50% more in the case of water – and additional facility maintenance. As such, the fixed OPEX of coal and gas plants increase by around 45%, and variable OPEX almost double.[13]

➢ High uncertainty and no learning effect

Proponents of CCUS are hopeful that learning effects come into play and reduce costs over time through innovation and efficiency improvements.[14] However, CCUS is not a new concept: the first large-scale demonstration projects were running from 1996 (Sleipner CCS) and 2000 (Weyburn Project).[15] Learning effects have not materialized since then and CCUS systems costs have instead followed an upward trend: from around US$2,900 per kW in 2007[16] to around a revised US$4,150 per kW in 2017 (expressed in 2022 terms).

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[12] Lazard, Lazard's Levelized Cost of Energy v15, Oct 2021, & Australian Energy Market Operator (AEMO), 2022 ISP: 2022 Forecasting Assumptions Update, 2022.
[13] IEEFA, CCS For Power Yet to Stack Up Against Alternatives, p.10, March 2023.
[14] S&P Global, Levelized cost of CO2 avoided (LCCA) for CCUS projects - Cost drivers and long-term cost outlooks, May 2022.
[15] Jinfeng Ma, Lin Li, Haofan Wang, Yi Du, Junjie Ma, Xiaoli Zhang, Zhenliang Wang, Carbon Capture and Storage: History and the Road Ahead, August 2022.
[16] IEEFA, CCS For Power Yet to Stack Up Against Alternatives, p15, March 2023 - based on IEA, Greenhouse Gas Research and Development Program (IEAGHG), Capturing CO2, May 2007.

RECLAIM FINANCE'S POSITION

Reclaim Finance is not in favour of the development of CCUS in the power sector. While it will have a role to play in achieving carbon neutrality as part of a 1.5°C-aligned scenario, it should be reserved for specific industrial sectors with no alternative for reducing CO2 emissions. In the power sector, CCUS appears to be a waste of money and presents the serious risk of slowing down GHG emissions reduction efforts. Financial institutions should not include CCUS for power generation in their energy transition financial and capacity targets, or in their energy transition frameworks.

Existing CCUS facilities in the power sector have proven not to be up to the task of reaching the theoretical 90% capture rate, achieving rates well below and failing to deliver promised emissions mitigations. CCUS engagement also results in higher fossil fuel consumption and higher methane emissions to produce the same amount of power as non-retrofitted power plants. In existing cases, captured CO2 is used to extract even more oil. This seriously compromises the pertinence of considering this technology as a climate solution.

Moreover, implementing CCUS requires large investments that drastically increase both capital and operational expenditure. The much higher costs per kW and higher exposure to volatile gas markets would likely incite the valorisation of captured CO2 instead of its storage. This indefinite storage is also yet to be proven. For the end-use consumer, deployment of CCUS at large scale would likely make the electricity wholesale price higher.

Far from being a solution, CCUS for power generation is making the climate crisis worse. Given the urgency of the situation, we must act swiftly to achieve a rapid and just energy transition. This requires actively reducing our reliance on fossil fuels, not delaying their phase-out. Instead of financing unproven technological bets like CCUS, financial institutions should focus support on sustainable energy sources, such as wind and solar, that are already commercially mature, competitive, and rapid to deploy.