Replacing end-of-life power stations with CCS coal-fired plants

A recent study has evaluated the economic and environmental merits of different designs of coal-fired power plants, all with carbon capture and storage (CCS), to replace an old power station in Germany. An integrated gasification combined cycle (IGCC) plant with pre-combustion CO₂ capture was found to offer the best profit for plant operators and significantly lower the life cycle emissions of CO₂.

Several of Europe’s power stations are reaching the end of their useful lives and plant operators face difficult decisions about how to replace them. The intention is to move towards non-carbon and renewable sources of energy, but coal is currently one of the most abundant and cheap forms of fuel. Building new coal-fired power plants with carbon capture and storage (CCS) units would allow the continued use of coal in the near-term whilst substantially reducing CO₂ emissions to the atmosphere from power generation. This has been proposed as an interim solution until other forms of energy become more economically and technologically feasible, although estimates as to when CCS will become commercially viable vary from 2015 to 2030.

This study assessed three different types of coal-fired power stations power plant, all with CCS, for their environmental impact and profitability. The designs have been proposed as replacements for the existing coal-fired power station in Kiel, Germany. The power plants were: an IGCC plant with pre-combustion carbon capture, a pulverised coal (PC) plant with post-combustion carbon capture and a pulverised coal plant with oxyfuel combustion carbon capture.

The profitability of alternative coal-fired power plants with CCS was assessed using three scenarios of possible future CO₂ permit prices, fuel prices and power revenues to plant owners. Results of the profit analysis suggest an IGCC plant with pre-combustion capture would be the best option in terms of economic returns for plant owners. An IGCC plant with CCS requires the least amount of fuel to operate the capture unit and is therefore more efficient than the other two types of plant. Oxyfuel technology is the most costly option for carbon capture.

In addition, the study investigated retrofitting CCS to an existing coal power station, either an IGCC plant or a PC plant. In both cases, fitting a CCS unit after the power plant has been built is less profitable than a plant with a CCS unit installed initially.

A life cycle analysis was used to compare the environmental impact of the different power plants. Although CCS considerably reduces CO₂ emissions from all plants, the reduction is not as great as estimated by other studies, which suggest reductions of up to 99 per cent. These figures typically refer to emissions only from the plant and do not take into account the increased energy demand of using CCS. For instance, life cycle emissions from a PC plant with CCS are only reduced by 67 per cent compared with a coal-fired plant without CCS, according to this study.

For plants retrofitted with CCS units, the plant life cycle emissions increase the longer the delay in fitting the CCS systems.


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