CARBON CAPTURE AND GEOLOGIC SEQUESTRATION FROM INTERMITTENT USE OF FOSSIL FUELS

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Essentially all scenarios for reducing greenhouse gas emissions require deployment of a portfolio of mechanisms. In this paper, I consider the interactions among different emissions reductions methods focusing on how much flexibility in source-sink matching and intermittent operation is possible in Carbon capture and sequestration (CCS) methods.

CCS is one of the mechanisms proposed to mitigate CO_2 released from stationary sources. Much of the previous evaluation has focused on electricity generation from traditional base-load power plants, especially those that use coal as an energy source. This is reasonable for several reasons: flue gas from coal combustion has high CO_2 concentrations, making post-combustion capture more efficient; coal has relatively high CO_2 emissions per unit of energy, so that mitigation is needed; gasifiers and other chemical processes are widely used on coal, providing concentrated CO_2 stream; and coal interest groups have organized programs to build "clean coal" programs in many regions. Coal has been widely used a base load power, with electricity from gas deployed as peak load.

Planning a capture system to run as continuously as possible lowers cost per ton abated and per kilowatt generated and a stable system reduces design complexity and risk. However, shifting energy systems show that the assumption that CCS will be applied to base load coal power may be limited, and more complex scenarios are needed. In US markets low prices for natural gas have caused a shift from coal to natural gas. A system designed to reduce overall emissions by shifting dispatch away from the most carbon intensive facilities, such as the US Clean Power Plan seems likely to incentivize fuel switching from coal to natural gas. Changes in deployment of nuclear generation may also impact dispatch order. Further, deeper application of intermittent renewables, smart grid, and energy storage seem likely to have impacts on dispatch order and correspondingly drive needs for CCS to be used intermittently and on generators who are supplied with natural gas. Increasing use of natural gas also creates different non-combustion CO_2 sources. Many unconventional gas sources have high CO_2 impurities, which must be removed prior to market, therefore mitigation of this CO_2 is part of the CCS picture. When natural gas is compressed to NLG, additional purification typically includes further lowering CO2.

Traditionally use of CO_2 for enhanced oil recovery is based on a steady stream from a natural source. CO_2 from gas separation is also available in a steady stream, however the addition of gas resources will shift the location of mitigation regionally and internationally, including to offshore settings. If fossil-fuel-powered electricity generation is used to back-stop intermittent renewables, captured CO_2 will be supplied only intermittently. An initial simplified study shows no harm to oil production from intermittent CO_2 injection during EOR. The most significant impacts from intermittency would be from the need to oversize surface facilities to accept the high end of variable volumes of CO_2. Further, the water-alternating- gas operation commonly used for EOR provides some confidence that intermittent CO_2 injection would not be technically difficult. The impact of intermittency on capture operations may shift emphasis to lower CAPEX operations, and further study is needed.