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Making New Amine Capture Plants Co-DACCS Ready: Options for Synergistic DACCS in Combination with Point Source CO_2 Capture

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Abstract

CO_2 emissions from point sources, such as power and energy from waste (EfW) plants and cement works can use post combustion capture (PCC) to remove CO_2 from exhaust fumes. However, any dispersed emissions of CO_2 must be captured indirectly and permanently stored in order to limit the global temperature rise to targets set out in the Paris Agreement of 2015 [1]. To reach this target, 10 $GtCO_2$/y must be removed directly from the atmosphere until 2050, after which 20 $GtCO_2$/y must be removed [2]. This can be done using direct air capture with CO_2 storage (DACCS) to remove CO_2 from the atmosphere and then send it to permanent geological storage.

Estimates of cost for the capture component of a large scale DACCS plant at 2022 cost levels fell within the range of 125 – 325 \$/tCO_2 [3], so a major research focus has been capital and operating cost reduction. An additional way to reduce DACCS costs is also to choose a favourable location, because the net CO_2 removal is independent of the geographical location of the DACCS activity.

It is evident that generic location-specific factors that affect the minimum selling price in \$/tCO_2 for DACCS will include the cost of land, cost and availability of local CO_2 storage and a transport network to storage, cost and availability of suitable energy sources (e.g. fossil fuels with CCS, renewable or nuclear energy), local construction cost indices, equipment site delivery costs, local financing costs, and the exchange rate for the local currency. It is also obvious that in a number of the countries currently deploying, or about to deploy, point source CCS – such as the UK and Western Europe – typical values for these factors are likely to give rise to globally-uncompetitive costs for stand-alone DACCS approaches that could equally well take place elsewhere in more favourable locations. DACCS approaches that have synergies with point source CCS, collectively termed Co-DACCS, may, however, have lower costs than stand-alone DACCS, perhaps low enough to offset at least some of the locational factors above. And, to some extent, the availability of point source CCS for Co-DACCS will always be in limited supply. The topic of this paper is therefore to examine ways in which Co-DACCS synergies might be realised, with a view

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to having developers consider making new point-source CCS plants and systems ‘Co-DACCS ready’ while it is still possible to do so and thereby increase the likelihood of globally-competitive DACCS deployment in the longer term in their countries.

Co-DACCS synergies with point source CCS fall into two main categories, additional and substitutional.

Additional Co-DACCS synergies arise when the point source CCS is running all or most of the time but resources and infrastructure can be shared at reduced marginal cost. Possible areas for all DAC technologies include CO_2 compression, transport and storage, permitting, planning, shared manning and maintenance and the supply of low-grade heat. Additionally, specifically for DAC combined with amine post-combustion capture (PCC Co-DAC) close integration between the amine use for air capture and flue gas capture has been shown to be able to reduce air capture regeneration energies to flue gas capture levels [4].

Substitutional Co-DACCS synergies arise when the DACCS take place out of phase with the point source CCS and uses facilities and infrastructure instead of the point-source capture activity, with effectively zero, or very low, marginal costs (but reduced availability factors). This is obviously likely to be most relevant for dispatchable power plants with CCS. In this case, with amine PCC being the main dispatchable CCS power plant technology currently being proposed, it is worth noting that PCC Co-DAC is still feasible with solvent storage.

This paper will present examples of possible Co-DACCS applications and the Co-DACCS ready preparations that might facilitate their subsequent deployment using two example PCC applications that are both attracting widespread deployment attention and for which detailed information is available in the public domain:

- Additive Co-DACCS: Amine PCC on baseload Energy from Waste (EfW) plants.
- Substitutional Co-DACCS: Amine PCC on dispatchable combined cycle gas turbine (CCGT) plants.

At this stage in its development there is significant uncertainty in future DAC technology details so, given readiness decisions have to be made now, the emphasis will be on the principles for achieving synergies rather than the theoretical DAC plant design and performance. For the same reasons, multiple potential DAC technologies will be considered, not just PCC Co-DAC.

Overall, this presentation aims to direct researcher and industry attention to a new, but relevant, topic - what is needed on new or retrofitted amine capture plants in order to make them Co-DACCS ready - while there are still opportunities to do so. By analogy with the well-established ‘CCS readiness’ approach, it will be shown that some modification that are low- or zero-cost at the early stages of a point-source CCS project have the potential to make significant reductions in the costs for elements of subsequent DACCS implementation.

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