CAN BECCS EFFICIENTLY AND SUSTAINABLY REMOVE CO_2 FROM THE ATMOSPHERE?

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Key Words: BECCS, climate mitigation, land use, water, carbon breakeven time

Bioenergy combined with carbon capture and storage, BECCS, could provide firm base load power while removing CO_2 from the atmosphere. This unique feature makes it the predominant solution in the IPCC AR5 scenarios (IPCC, 2014) where it accounts for a substantial fraction of primary energy supply in half of the emissions pathways (Fuss et al., 2014). Such a demand for biomass would require large, integrated supply chains, whose embedded emissions could not only challenge the carbon negativity of BECCS – the underpinning concept of this option – but would also compete with other resources – such as water and land - already affected by global warming (UN Water, 2005). In this contribution, we present a whole-systems analysis of the biomass supply chain associated with a range of bioenergy materials – both energy dedicated crops (miscanthus, switchgrass, short rotation coppice willow), and agricultural residues (wheat straw) – supplied from different regions and land types, and converted in dedicated fired power stations in conjunction with post-combustion CCS technology. The water, carbon and energy footprints of each combination were calculated and their impact on the overall system net water intensity, power generation efficiency, and carbon intensity was measured. The model was evaluated with a range of values for each input parameter to capture the high variability and uncertainty in literature data. In order to describe the dynamic greenhouse gases (GHG) emissions of such as system, a yearly accounting of the emissions was carried out over a BECCS power plant lifetime, and the system carbon breakeven time was determined (Withers et al., 2015). Finally, a sensitivity analysis was carried out on the dynamic GHG emissions profile, and alternate scenarios involving organic chemicals, biofuels with and without CCS and carbon neutral electricity were investigated. Direct and indirect land use changes (Fargione et al., 2008; Plevin et al., 2010; Searchinger et al., 2008) effects were measured on both static and dynamic balances, and were found to be driving the results and uncertainty range. Overall we concluded that depending on conditions of its deployment, BECCS could lead to both carbon positive and negative balances. The most sustainable case study, miscanthus-based BECCS from Brazil, could lead to break-even times between 1 year if grown on marginal land, and 50 years on a forest land. Regulating and rewarding policies will have to integrate this local specificity in order to assure BECCS sustainable development.

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