BECCS optimal deployment: the value of collaboration

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Abstract

Unprecedented changes in the energy system are required to limit global warming to 1.5°C by the end of the century, including the deployment of carbon dioxide removal methods (IPCC 2018). In delivering on this goal, bioenergy with carbon capture and storage (BECCS) is likely to play an important role, both as a climate mitigation – by delivering low carbon energy – and a carbon dioxide removal technology (Fuss et al. 2018). Yet, regional drivers of BECCS sustainability and cost over time remain broadly unknown, while policies required to foster and regulate BECCS deployment are lacking (Nemet et al. 2018; Fajardy et al. 2019; Gambhir et al. 2019). In this study, BECCS full value chain is modelled in the Modelling and Optimisation of Negative Emissions Technologies (MONET) framework, explicitly accounting for the water, land, CO\textsubscript{2}, energy and financial costs of producing, transporting and converting biomass in BECCS plants, and storing CO\textsubscript{2} in geological reservoirs, in five representative regions: Brazil, China, the EU, India and the USA. We use this framework to elucidate the mechanisms behind the cost-optimal deployment of BECCS under land and water use constraints, and how it evolves over time, with an increasing CO\textsubscript{2} removal target, the depletion of CO\textsubscript{2} storage sites and the decarbonisation of the energy sector. To assess the impact of bioenergy availability and CO\textsubscript{2} removal targets on the resource efficiency and cost of BECCS optimal value chain, the following scenarios are considered: 1a) a low bioenergy availability (only energy crops from marginal land) and 1b) a high bioenergy scenario (energy crops from marginal land, cropland, grassland and forest land, and agricultural residues; 2a) a low target scenario (following SSP1 of IPCC scenarios, equivalent to 149 GtCO\textsubscript{2} removal) and 2b) a high target scenario (following SSP2 of IPCC scenarios, equivalent to 408 GtCO\textsubscript{2} removal). Different levels of biomass trading – whether a BECCS plant in region A can use biomass from region B – and CO\textsubscript{2} negative emissions trading – whether region A can store CO\textsubscript{2} on behalf of region B – between regions were also considered to quantify the value of inter-regional collaboration.

At low targets, when bioenergy supply is not a limiting factor, the cumulative cost of CO\textsubscript{2} removal decreases over time, which shows that decarbonisation of the energy sector and BECCS plant potential capital cost reductions may outweigh a potential cost increase from scaling up bioenergy production. At higher targets however, when reaching biophysical limits in biomass supply, BECCS cost can increase past the $100-350/tCO\textsubscript{2} range, which indicate

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deployment opportunities for arguably more expensive, but less resource intensive, carbon dioxide removal technologies (e.g., direct air capture). A key finding is that cooperation – in establishing clear regional targets – and collaboration – in trading negative emissions and biomass – between regions is key in maximising chances to meet CO₂ removal targets at the lowest cost. In a cooperative and collaborative environment, critical providers CO₂ storage and biomass (e.g., Brazil and China) emerge. The availability of a well distributed CO₂ storage sites network being a key driver of BECCS cost, CO₂ storage capacity assessment efforts should focus on regions critical to CO₂ removal.

**Keywords:** BECCS, CO₂ removal, collaboration, optimisation.

**References**


