Climate vs energy security: quantifying the tradeoffs of BECCS deployment and overcoming opportunity costs on set-aside land.

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ABSTRACT

Bioenergy with carbon capture and storage (BECCS) sits at the nexus of climate and energy security. Yet central to most climate stabilization scenarios, the deployment of BECCS at meaningful scales poses a risk to sustainable development. Here, we evaluated the tradeoffs of pathways to implementation led by inherently different priorities to support either climate stabilization (i.e. negative emissions and net climate benefit) or energy security (i.e. ethanol production). Further, central to the sustainable deployment of BECCS, we estimated the cost of sidestepping indirect changes in land use. Results from our spatially explicit biogeochemical – life-cycle model indicate that the foregone climate benefit from abandoned cropland (opportunity cost) increased carbon emissions per unit of energy produced by 14-36%, roughly doubling breakeven times for the initial carbon debt of land conversion and making geologic carbon capture and storage necessary to achieve negative emissions from any given energy crop. The toll of opportunity costs on the climate benefit of BECCS from set-aside land was offset through allocation of crops spatially based on their individual biophysical constraints. Led by biomass productivity, dedicated energy crops were consistently chosen over mixed grasslands. Our results estimate that BECCS allocation to land enrolled in the Conservation Reserve Program (CRP) could capture up to 9 TgC y^{-1} from the atmosphere, deliver up to 16 TgCE y^{-1} in emissions savings, and meet up to 10% of the US energy statutory targets, but contributions varied substantially as the priority shifted from climate stabilization to maximizing energy provision. An energetically optimal deployment would generate 13.3 billion liters of ethanol annually but would reduce negative emissions by 21% and the net climate benefit of BECCS by 15% relative to alternative optimization strategies. Our results indicate a significant potential to integrate energy security targets into sustainable pathways to climate stabilization but underpin the tradeoffs of divergent policy-driven agendas and the repercussions for how future action portfolios will be mapped and executed.

SESSION

GC063 - Leveraging Multifaceted Approaches to Carbon Dioxide Removal For Effective Climate Change Mitigation

To meet the Paris Agreement's goal of limiting global warming to 1.5-2.0°C, approximately 10 GtCO2 per year must be removed from the atmosphere by 2050 to achieve net zero emissions. Multiple carbon dioxide removal (CDR) approaches have been proposed to achieve this goal, including natural approaches (e.g., forest management, wetland restoration, soil carbon sequestration), tech-driven approaches (e.g., air capture and enhanced weathering), and combinations of these approaches. As a community, we must not only develop innovative approaches, but also evaluate their effectiveness, efficiency, co-benefits, and unintended consequences, i.e., Measure, Monitor, Report, and Verification (MMRV). This session will focus on evaluating current CDR approaches, justifying the potential for broader application, proposing new approaches, and exploring combinations of CDR approaches. This session aims to bring together scientists from different fields to address and discuss our current understanding of CDR approaches to efficiently and continuously reduce atmospheric CO2 concentrations.

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