Global climate change mitigation potential of bioenergy with carbon capture and storage (BECCS)

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1-3 See below

Research aims

• Provide a geospatially-explicit global analysis of (negative) GHG emission factors (EFs) for BECCS
• Assess global potential of BECCS at increasing EFs, for different original land cover categories
• Determine how feedstock type and final carriers affect BECCS EFs and potentials

Approach

• EFs are based on 1) CO2 emissions from carbon stock changes, 2) N2O emissions from fertilisers, 3) supply chain GHG emissions, and 4) sequestered CO2 emissions through CCS.
• Bioenergy potential is based on yields, feedstock energy content and conversion efficiencies.
• Carbon stocks and bioenergy crop yields are modelled in IMAGE-LPJml (agricultural land is excluded), while the other parameters were based on an extensive literature analysis.

Motivation

Bioenergy with carbon capture and storage (BECCS) can result in so-called net negative greenhouse gas (GHG) emissions and could thus strongly contribute to climate change mitigation.

However, the production of bioenergy may lead to land-use change (LUC) emissions thus reducing the total negative emissions achieved by BECCS.

As LUC emissions vary depending on the original land cover, the appropriateness of feedstock cultivation for BECCS may be very location specific.

Results

Bio-energy

Bioelectricity no CCS

Bioelectricity with CCS

Biofuel no CCS

Biofuel with CCS

Fig. 1 Bioelectricity from lignocellulosic biomass (20 year time horizon)

Fig. 2 Lignocellulosic ethanol

Fig. 3 Lignocellulosic Fischer-Tropsch diesel

Fig. 4 Sugarcane ethanol

Preliminary Findings

• High EFs compared to fossil benchmarks (20 yr time horizon)
• Negative EFs for bio-electricity with CCS, but only in some locations
• No negative EFs for biofuels with CCS
• Generally lower EFs in sub-tropics and warmer temperate areas that have relatively high yields, but do not have the very large carbon stocks found in natural tropical and boreal forests.

Future Avenues

• Determine optimal mix of bioenergy feedstock, final carrier and location for climate change mitigation
• Assess sensitivities of these results to variation in climate, conversion efficiencies and supply chain emissions, and land cover scenarios (based on SSP 1-3)