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

S.V. Hanssen[1*], V. Daioglou[2], J.C. Doelman[2], Z.J.N. Steinmann[1], D.P. Van Vuuren[2,3], M.A.J. Huijbregts[1]

*Presenting; contact: s.hanssen@science.ru.nl [1-3] See below

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**.

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) CO_2 emissions from carbon stock changes, 2) N_2O emissions from fertilisers, 3) supply chain GHG emissions, and 4) sequestered CO_2 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.

Results

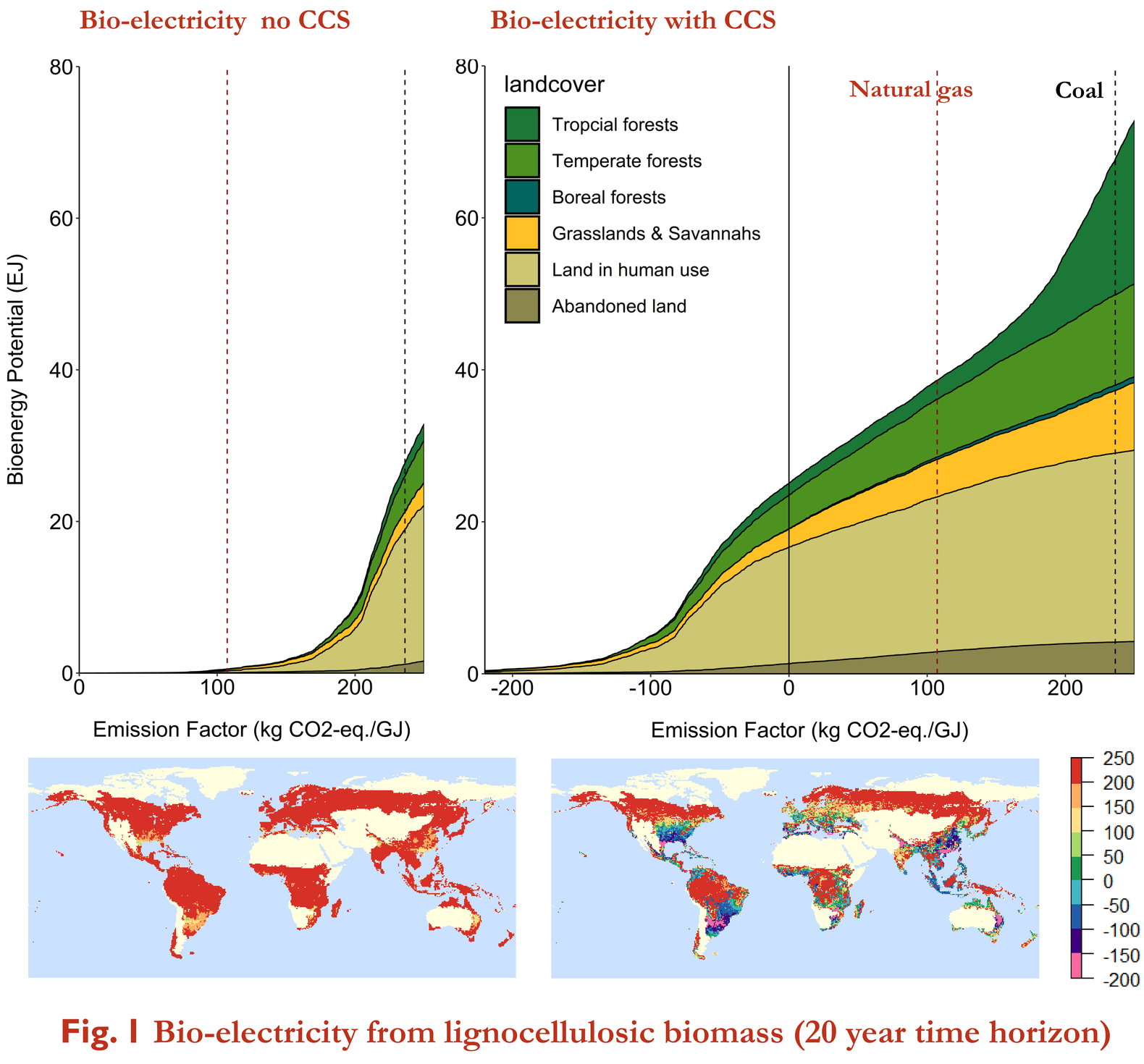

Fig. 1 Bio-electricity from lignocellulosic biomass (20 year time horizon)

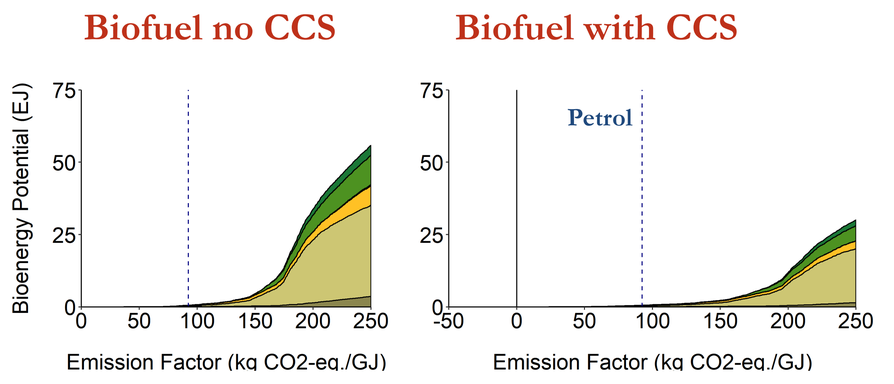

Fig. 2 Lignocellulosic ethanol

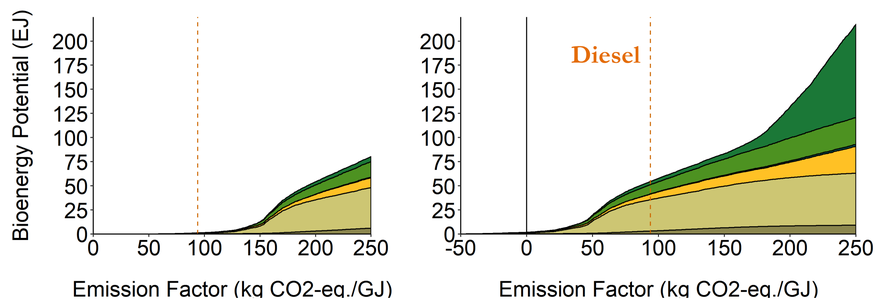

Fig. 3 Lignocellulosic Fischer-Tropsch diesel

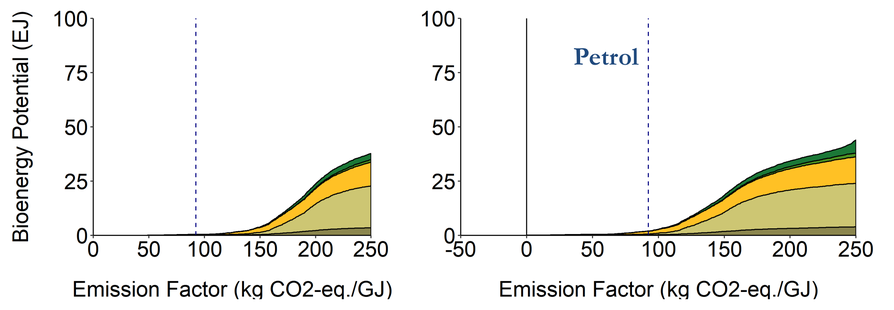

Fig. 4 Sugarcane ethanol

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)

[1]Department of Environmental Science, Institute for Water and Wetland Research, Radboud University, P.O. Box 9010, 6500 GL Nijmegen, The Netherlands, [2]PBL Netherlands Environmental Assessment Agency, P.O. box 30314, 2500 GH The Hague, The Netherlands, [3]Copernicus Institute of Sustainable Development, Utrecht University, Heidelberglaan 2, 3584 CS Utrecht, The Netherlands.

PBL Netherlands Environmental Assessment Agency

Radboud University