Potential of achieving climate target with bioenergy is limited

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Large-scale implementation of bioenergy with carbon capture and storage (BECCS) is often considered to be an important measure to reach the climate targets set out in the Paris Agreement. A new study

from researchers at Radboud University, Utrecht University and the PBL Netherlands Environmental Assessment Agency shows, however, that over a period of 30 years, BECCS can only play a modest role. Evaluating BECCS over the full 21st century (80 years) does lead to a different picture: the total potential could be as large as current CO_2 emissions, but comes at the costs of substantial land requirements. The research will be published in *Nature Climate Change* on 24 August.

The Paris Agreement aims to limit the rise in global temperature to well below 2 degrees Celsius and preferably 1.5 degree. Many scenario studies suggest that bioenergy with carbon capture and storage, in short BECCS, can be a key technology in reaching these targets. With BECCS, biomass production serves as a carbon sink during its growth phase. By subsequently capturing CO_2 after combustion of the biomass and storing it in geological storage locations, BECCS can in fact remove CO_2 from the atmosphere. The net balance of BECCS depends, however, not only on the CO_2 stored underground but also on the CO_2 emissions created during biomass processing, transport and production.

A proper evaluation of the BECCS potential for negative emissions therefore needs to account for several key factors, such as the location of biomass production, the time-period over which the impact is evaluated and the type of energy produced. The researchers of Radboud University, PBL Netherlands Environmental Assessment Agency and Utrecht University were able to use a unique computer model that takes all these factors into account evaluating the potential of BECCS from lignocellulosic feedstock worldwide.

BECCS potential

Steef Hanssen (researcher at Radboud University), first author of the study, explains: "Earlier deployment of BECCS greatly increases its climate change mitigation potential. When evaluated over the next thirty

years, the maximum global potential of BECCS is 28 exajoule (1 exajoule = 10^{18} joule) per year for electricity with negative emissions, sequestering 2.5 Gtonne (Gigatonne; 1 Gtonne = 10^9 ton) of CO_2 per year (about 5% of current global emissions). Over the full century, the potential can be much larger, up to 220 EJ per year and 40 Gtonne CO_2 per year in the most optimistic case. This is about the same as current emissions, indicating a considerable biophysical potential for bio-energy."

The results for the next thirty years are, however, particularly sensitive to what happens with the initially present vegetation before plantation establishment. "It is evidently better to use initial biomass for energy or materials rather than burning it," Hanssen stresses. "If the initial biomass is also used to produce bio-energy or in other sectors for timber or paper, the sequestration potential of BECCS electricity increases sharply from 2.5 up to between 5.9 and 11 Gtonne CO_2 per year."

Large amounts of land required

Full global implementation of BECCS to reach the climate targets would, however, lead to large land requirements, possibly leading to competition with other land uses such as food production and biodiversity protection. In the most extreme cases, up to 0.8 to 2.4 billion hectare of land is required by 2100 to grow lignocellulosic crops for BECCS, which equals 5 to 16% of the total land surface area on Earth.

Detlef van Vuuren (PBL and Utrecht University) adds: "The use of BECCS should be carefully considered. While it has a unique contribution in taking CO_2 from the atmosphere, this comes at a clear costs of extensive land use. It should, therefore, only be used in combination with more important options for GHG (Greenhouse Gas) emission reduction, including lifestyle changes and more extensive use

of other sources of renewable energy and the costs and benefits should be carefully considered. Only then can we reach the greenhouse gas emission reduction and carbon dioxide removal that the Paris Agreement aims for."

More information: S. V. Hanssen et al. The climate change mitigation potential of bioenergy with carbon capture and storage, *Nature Climate Change* (2020). DOI: 10.1038/s41558-020-0885-y

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