Market dialogue biochar aid scheme

Green Transition Denmark (hereafter GTDK) has one main input to the Market dialogue biochar aid scheme.

1. The award criteria chosen does not correspond to the objective of the biochar aid scheme to incentivize negative emissions.

Overall, the subsidy scheme was established to incentivize carbon removal from the *atmosphere*. But the award criteria – subsidy per ton of carbon stored permanently in Danish mineral soils – does not ensure this:

Carbon stored biochar and applied to mineral soils does not reflect the net CO2 removal from the atmosphere for two main reasons:

- Loss of biogenic carbon stores must be deducted: The carbon in biochar originates in biomass inputs for the pyrolysis process, and extraction of this biomass from nature reduces natural carbon stores. Merely transferring biogenic carbon from nature into biochar does not reduce atmospheric CO2-content. Hence, the loss of biogenic carbon pools must be considered, when quantifying the net removal of CO2 from the atmosphere. Losses are higher for biogenic inputs with long decay times, e.g. wood and biogas digestate versus biomass with short decay times like straw.
- Pyrolysis process carbon losses: The pyrolysis process implies significant conversion losses, which translates into lower net CO2 removal from the atmosphere. Losses differ between types of biomass inputs and the type of pyrolysis used.

The combined effects of these two points are depicted in figure 1 -3 below:

Figure 1: Net carbon removal from pyrolysis of wood, 9% process-energy loss

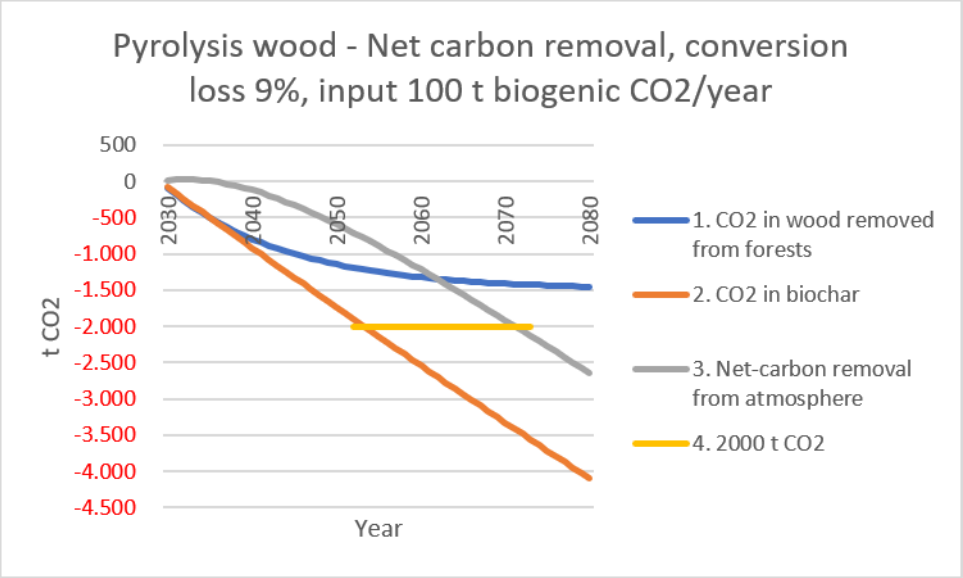

Figure 1 on pyrolysis of **wood** is calculated based on the carbon balance described in the 2022 Technology Catalogue[i] chapter on slow pyrolysis on straw plus a decay function for waste wood calculated from IPCC standard factors. 50% of carbon in raw wood input ends up as biochar.

The net carbon removal (curve 3) is calculated as the difference between the amounts of biochar stored in fields (curve 2) and CO2 removed from forests (curve 1). As can be seen the net CO2 removal in curve 3 is significantly lower than the amount of biochar-carbon stored in fields (represented in curve 2). Curve 4 indicates the time it takes before net-carbon removal equals CO2 stored in biochar – in this case around 18 years.

Pyrolysis oil and -gas is treated as separate products in this calculation, and carbon in the biogenic input diverted for these two fuels is not part of the curves in this figure. All CO2 emitted due to process energy use is attributed as loss of CO2 in the pyrolysis process - in this calculation 9% of total carbon input into the pyrolysis process including carbon diverted for pyrolysis oil and -gas.

Figure 2: Net carbon removal from pyrolysis of wood, 15% process-energy loss

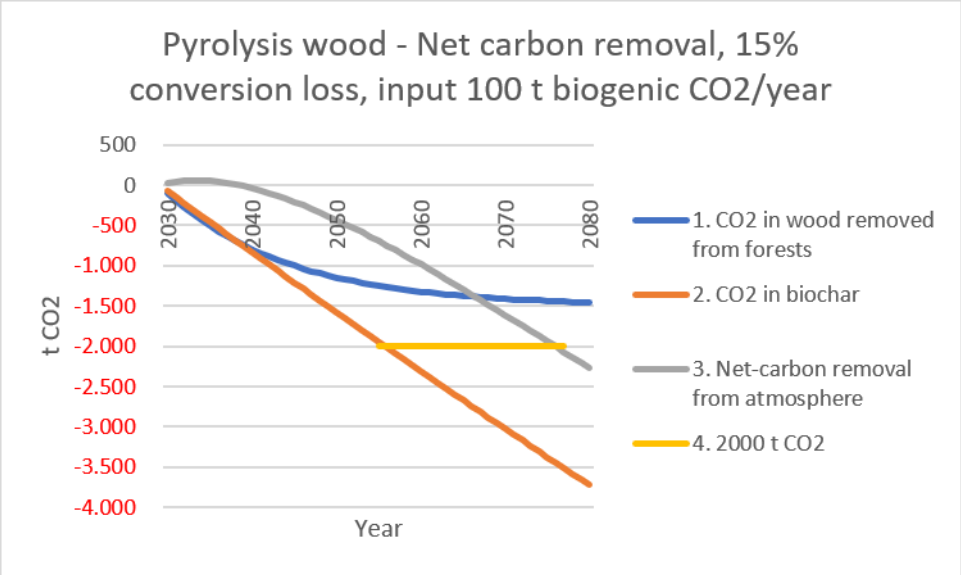

Figure 2 assumes a process-energy loss of 15% whereas figure 1 assumed 9%. As indicated by curve 4 In figure 2 higher conversion losses imply longer time before net-carbon removal equals CO2 stored in biochar – in this case around 20 years.

Figure 3: Net carbon removal from pyrolysis of straw

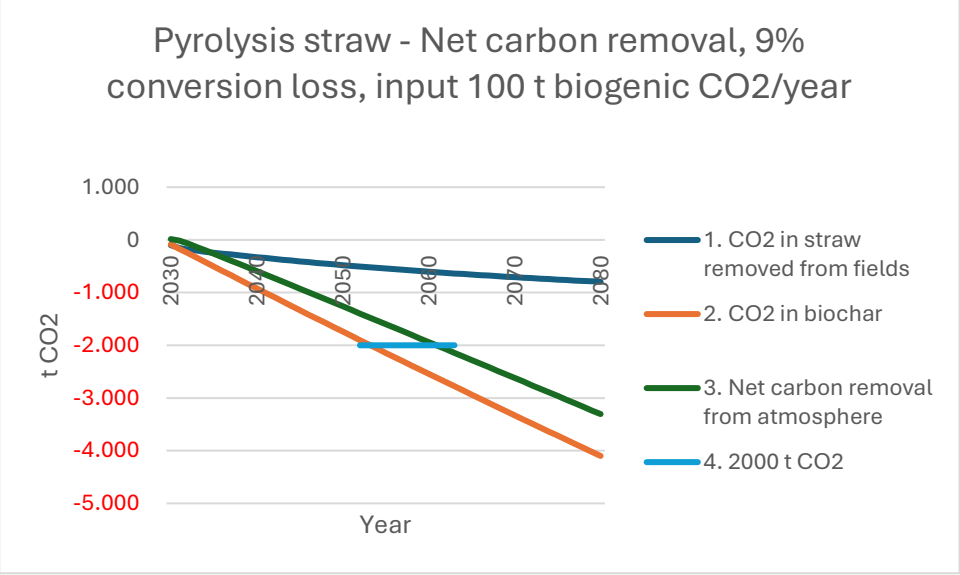

Figure 3 on pyrolysis of **straw** is calculated based on the carbon balance described in the 2022 Technology Catalogue chapter on slow pyrolysis on straw plus a decay function for straw from Thers et al.[ii] 50% of CO2 input to the pyrolysis process ends up in biochar. Straw decays much faster than wood

– hence the loss of carbon pools in nature are smaller than for wood. Curve 4 indicates the time it takes before net-carbon removal equals CO2 stored in biochar – for straw still around 8 years.

Pyrolysis oil and -gas is treated as separate products also for the straw calculation, and carbon in the biogenic input diverted for these two fuels is not part of the curves in this figure. All CO2 emitted due to process energy use is attributed as a loss of CO2 in the pyrolysis process – here 9% of total carbon input to the pyrolysis process.

Conclusion

Figures 1, 2 and 3 illustrate that a ton of CO2 in biochar stored does not equal a ton of CO2 removed from the atmosphere. And that the discrepancy between these two numbers vary significantly according to process energy losses and in particular type of biomass input to the pyrolysis process.

Consequently, the award criteria should be "Price per ton of CO2 removed from the atmosphere".

To document CO2 removed from the atmosphere biochar suppliers must provide independent, third party verification of CO2 removed from the atmosphere. The Danish Energy Agency should issue specific rules for such calculations.

CO2 removed from forests and fields will be reflected in national LULUCF accounts as a loss of carbon. That is: If proper LULUCF registering and accounting is undertaken by the state of origin for the wood or straw supplied to the pyrolysis process. UNFCCC rules only require detailed LULUCF accounting from Annex I parties to the Climate Convention. Therefore, only wood originating in Annex I countries should be allowed as inputs to biochar offered in the biochar tender.

[i] *Technology catalogue, Danish Energy Agency, 2022*

[ii] *Jensen JL, Thers H, Elsgaard L. 2022. Afklaring om videns- og ressourcebehov ved at integrere biokul i C-TOOL modellen til brug for emissionsopgørelser. DCA – Nationalt Center for Fødevarer og Jordbrug, Aarhus Universitet.*