Policy Brief

INNOPATHS

Biochar for Decarbonisation

Biochar can remove carbon from the atmosphere but, like other negative emissions technologies, its wide diffusion will require strong policy support

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Key Messages

- The biochar system is an exceptional negative emissions technology (NET) that can remove carbon from the atmosphere and store it in soil, thereby improving soil and conserving water, as well as having other possible uses.
- The lack of an enabling and supportive policy framework at the EU level, has been the main barrier to widespread diffusion of the biochar system.
- Widespread diffusion of the biochar system will require its greenhouse gas removals from the atmosphere to be financially rewarded, but its many benefits could then lead to wide public acceptance.
- The policy framework to support NETs, including biochar, needs urgently to be agreed and implemented.

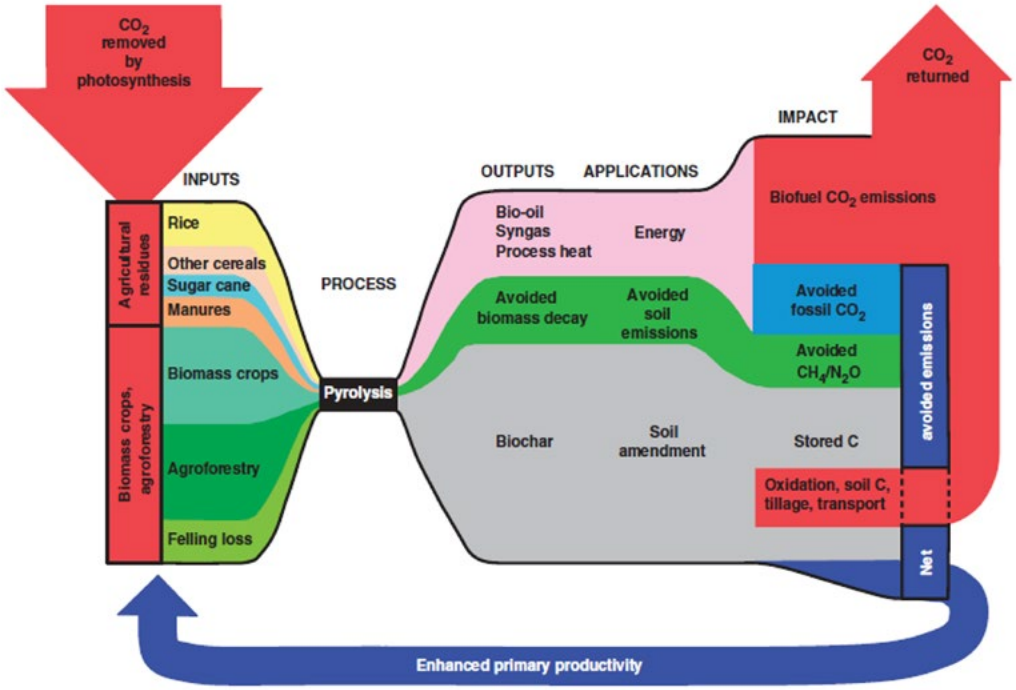
Background and Context

For the international community to meet the goal of the Paris Agreement, namely holding the increase in the global average temperature to well below 2°C above pre-industrial levels, some large-scale deployment of negative emissions technologies (NETs) is most likely needed, to offset residual greenhouse gas (GHG) emissions that are technically impossible or too costly to eliminate, as well as to recover from possible overshoots of GHG emissions. Broad categories of NETs are: a) industrial processes, such as bioenergy with carbon capture and storage, b) direct air carbon capture and storage, and c) ecosystem management approaches. The biochar system belongs to the last category, which also includes afforestation and reforestation, soil carbon sequestration practices, blue carbon, enhanced weathering, and ocean fertilization. Over the past decade, the biochar system has received increasing attention.

Biochar itself is a solid carbon-rich material obtained from the heating of biomass in the (near) absence of oxygen, in a process called pyrolysis. It can be made from different feedstocks, including wood, straw, organic wastes, animal manure, digestates, and sewage sludge. When obtained from wood, biochar is indistinguishable from charcoal. The difference is in its use: while charcoal is made to be burnt as a fuel, the typical use of biochar is for improving agricultural soil. When applied to soil, most of the biochar remains there in a stable form for hundreds or even thousands of years. The production-use cycle in which biochar is first obtained from biomass through pyrolysis and then used for improving agricultural soil or for any other purpose that does not result in GHG emissions is referred to as the 'biochar system' (BS).

Estimates of the negative emissions potential of the BS vary widely. For example, authoritative estimates include 1.1 $GtCO_2$-eq per year [1], 2.6 $GtCO_2$-eq per year [2] and 6.6 $GtCO_2$-eq per year [3], which correspond to 1.9%, 4.6% and 11.9% of current global GHG emissions. The BS produces multiple biochar co-products, including syngas, bio-oil, and process heat, which could be used as renewable energy sources to replace fossil fuels in energy generation (Figure 1).

Figure 1 – Flowchart of the biochar system.



Source: [3]

The biochar system is an exceptional negative emissions technology (NET) that can remove carbon from the atmosphere and store it in soil, thereby improving soil and conserving water, as well as having other possible uses.

In the realm of NETs, the BS stands out as having a relatively low cost of climate mitigation, which varies depending on site-, feedstock-, and process-specific conditions of biochar production, as well as other benefits. The quantity of carbon permanently sequestered through BS can be accurately measured, as compared to other land-based NETs, such as minimum tillage and permanent soil cover. In addition to the capture and sequestration of CO_2 from the atmosphere, the BS also improves agricultural soils, and can boost crop yields, and promotes water conservation, by increasing the organic carbon content of soils and their water retention capacity. There are other possible uses of biochar that either precede its final application to the soil or that do not involve addition to the soil at all, but still result in long-term carbon sequestration. However, to realise the environmental and economic potential of biochar at scale, both via its ecosystem services and its many possible uses in innovative value chains, environmental and sectoral policies and regulations need to be well integrated.

The lack of an enabling and supportive policy framework has been the main barrier to widespread diffusion of the biochar system.

In the EU, the diffusion of the BS as a NET and as a multi-purpose sustainable technology has so far been precluded by the lack of an enabling and supportive policy framework. The fact that net GHG emissions from land use, land-use change and forestry (LULUCF) did not count toward the EU's 2020 emissions reduction target (20% reduction below 1990 levels) is a case in point. Mainly as a result of the European Green Deal, however, the institutional context relevant to the BS is quickly changing, in a favourable way. Recent key developments at the EU level include: a) the adoption of the new Fertilising Products Regulation, with which biochar has made its first appearance in EU legislation; b) the proposed reform of the Common Agricultural Policy (CAP) for the period 2021-2027, in which stronger support for soil carbon sequestration is very prominent; c) the adoption of a new Circular Economy Action Plan by the European Commission; d) the announcement by the European Commission of an EU certification system for carbon removals by 2023; e) increased ambition in climate change mitigation as reflected in the new EU targets of climate neutrality ('net-zero' emissions) by 2050 and 'at least 55%' emissions reduction by 2030; and f) the taking into account of net GHG emissions from LULUCF toward the achievement of the 2030 emissions reduction target. All these developments suggest that tailored regulation and policy support for the BS, at the EU and member state levels, may not be far off, though at present it remains undefined.

Widespread diffusion of the biochar system will require its greenhouse gas removals from the atmosphere to be financially rewarded, but its many benefits could then lead to wide public acceptance.

Without significant policy changes such as those mentioned above, biochar production in the EU will remain very modest. Indeed, beyond the market of organic soil improvers, demand for biochar is usually insufficient to spur its production. Since the quantity of sequestered carbon is the sole outcome that matters when it comes to climate mitigation, the BS as a NET can only be of interest if it is deployed at large scale. Policy support that monetises the added social value of biochar use in terms of climate mitigation, as well as restoration of soil carbon, is of the essence for the economic viability of new scalable business models with biochar at their core. The European Commission is aware of this and, today, the question is which policy instrument should be used for that purpose (see next paragraph). If the agronomic benefits of the BS are ignored, the abatement cost of the BS (€/tCO_2) indicates the level of reward needed to make BS projects economically viable. Depending on specific conditions of biochar production, estimates of the abatement cost vary widely, from as little as €20/tCO_2 up to ten times as much, or even more. Like most bioenergy value chains, the cost of the feedstock is particularly important. However, capital expenditure also becomes relevant for industrial-scale biochar production. Once EU regulations for safe production and uses of biochar as well as for the certification of GHG removals are in place, appropriate reward of GHG removals – and ideally of soil carbon restoration too – would start stimulating the most cost-competitive projects. As regards non-economic barriers to uptake of the BS, empirical evidence is scant. Public acceptance is not expected to be a major issue, as the co-benefits of properly regulated biochar applications may well appeal to farmers, who would, however, need dedicated training to maximise the potential benefits.

> Policy support that monetises the added social value of biochar is of the essence for the economic viability of new scalable business models

The policy framework to support NETs, including biochar, needs urgently to be agreed and implemented.

Different policy instruments could be used to reward GHG removals achieved through the BS. Options include: a) granting payments to farmers under the CAP (€ per tonne of CO_2 removed from the atmosphere), which probably would be the quickest and most convenient way to kick-start BS uptake; b) establishing an obligatory market for certificates of GHG removals, similar to that of tradable green certificates for renewable energy; and c) introducing a quota of GHG removals as offsets in the EU ETS. Importantly, from a policymaker's perspective, which of these options (and possibly others) is preferable is not immediately obvious. One reason is that there is far from a consensus on the equivalence of emission reductions and removals as ways to stabilise the climate. A major concern is that, at a macro level, large substitution of the latter for the former would expose society to the risk of getting locked into a high temperature pathway. Having separate targets would prevent the risk of delaying emission reductions or removals. Separate targets would also enable effective (targeted) support for specific NETs or outcomes. As it stands, the EU's 2050 net-zero emissions target does not contain specific targets for emission reductions or GHG removals. Although in the light of past EU climate and energy policy it seems likely that specific objectives for GHG removals will be set, the process of establishing targets and instruments will take some time. In the meantime, other possible instruments should be implemented so that the societal benefits offered by the BS can be exploited without delay.

"Different policy instruments could be used to reward GHG removals achieved through the biochar system"

Further Information

For further information, please consult the following publications:

- Verde, S.F. and I. Alloisio (2019), *Biochar for climate mitigation in the EU: an innovation system perspective*, in: Verdolini, E. (ed.), *Report on the sectoral and national (plus EU) innovation system case studies* (D2.4), INNOPATHS - Innovation pathways, strategies and policies for the Low-Carbon Transition in Europe.
- Verde, S.F and D. Chiaramonti (2021), *The biochar system in the EU: the pieces are falling into place, but key policy questions remain*, EUI Policy Brief RSCAS 2021/18.

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2 Smith, P., Davis, S., Creutzig, F., Fuss, S., Minx, J., Benoit, G., … and C. Yongsung (2016), Biophysical and economic limits to negative CO_2 emissions, Nature Climate Change, 6, 42-50.

3 Woolf, D., Amonette, J.E., Street-Perrott, F.A., Lehmann, J. and S. Joseph (2010), Sustainable biochar to mitigate global climate change, Nature Communications, 1(56).

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