Biochar: a long-lived form of Carbon removal

David Chiaramonti, Politecnico di Torino, Italy
Johannes Lehmann, Cornell University, USA
Franco Berruti, Western University, Canada
Paola Giudicianni, National Research Council, Italy

Permanent Carbon Removals: Biochar Carbon Removal (BCR)

Carbon Dioxide Removals (CDR) are an essential part of our global and EU efforts to achieve the agreed climate targets for 2050 and to limit global warming to at least under 2°C by the end of the century. Accurate quantification, tracking and certification of the amount of carbon actually removed from the atmosphere are essential elements of a credible and long-lasting action.

Biochar Carbon Removal (BCR) is the most technically advanced and scalable permanent CDR at present and for the foreseeable years to come. In 2022, BCR accounted for 87% of all permanent carbon removal deliveries, at by far the lowest cost of any durable carbon removal[1] and with all co-benefits that other industrial CDR options do not offer, first of all supporting the transition to regenerative agriculture and sustainable forestry. It has a high feasibility compared to other land-based carbon dioxide removal strategies. A large set of literature (such as [2, 3]) estimated the large contribution that biochar can offer to CDR at global scale: in the European region, total emission reductions was estimated at 133 million tons CO_2e per year [4]. The biochar industry[5] estimates carbon dioxide removals of 10 million tons CO_2 in 2030 and almost 100 million tons CO_2 in 2040.

BCR is a readily available and scalable technology with a high Technology Readiness Level (TRL). Also, BCR can be tracked, certified and accounted based on sound evidence and measurements. Carbon removal standards with biochar methodologies currently exist that provide rigorous accounting for sustainable net removals[6]. Digital MRV (Monitoring,

[1] CDR.fyi. 2022 Year in Review. https://medium.com/cdr-fyi/cdr-fyi-2022-year-in-review-d095acd9a1a0

[2] Bossio, D.A., Cook-Patton, S.C., Ellis, P.W. et al. The role of soil carbon in natural climate solutions. Nat Sustain 3, 391–398 (2020). https://doi.org/10.1038/s41893-020-0491-z.

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[5] European Biochar Industry Consortium. European Biochar Market Report 2021-2022. https://www.biochar-industry.com/wp-content/uploads/2022/03/EU-Biochar-Market-Report_2022-03-09.pdf (2022).

[6] Puro Standard: https://puro.earth/puro-standard-carbon-removal-credits/; VERRA VCM Biochar Methodology: https://verra.org/wp-content/uploads/imported/methodologies/210803_VCS-Biochar-Methodology-v1.0-.pdf; EBC C-Sink Guidelines: https://www.european-biochar.org/en/ct/139-C-sink-guidelines-documents

Reporting and Verifying) providers offer tracking of biochar and the carbon conserving end use[7].

Biochar's persistence in the environment: Permanence

Solid scientific evidence confirms biochar's durability in the environment over long periods of time (long-lived Carbon sequestration). Among others, the European Commission itself through its Joint Research Center (JRC) has carried out a detailed and evidence-based assessment of the long-lived Carbon removal nature of biochar[8,9,] as also found in the Terra Preta case, which Carbon persisted for many centuries. Today all this is well known and demonstrated based on experimental evidence, and broadly described in the scientific literature that JRC reported in its meta-analysis (such as[10, 11, 12]). These models have been included in guide to national greenhouse gas account published in 2019 by the Intergovernmental Panel on Climate Change (IPCC) and are accepted as the basis for carbon trading platforms on the existing voluntary carbon markets.

Biochar Permanence in the IPCC

IPCC's guidance is recognized as a metastudy that most people rely on. The recent report "Climate Change 2022 - Mitigation of Climate Change" assumes that about 80% of the stored carbon in biochar can be sequestered over a period exceeding 100 years , and, therefore, considered permanent[13] for mitigation purposes. Evidence also exists from geological studies that the carbon in biochars can reach properties that are considered chemically non-generative or inert and thus geologically stable[14].

Multiple co-benefits of biochar for the environment and the society

Biochar, beyond contributing to Climate Change Mitigation, can play a key role in restoring soil health, promoting water retention and crop resilience towards changing precipitation regimes and extreme weather events, creating conditions conducive to

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7 Carbonfuture MRV+: https://www.carbonfuture.earth/products/mrv

8 European Commission, Joint Research Center. IMAP Project. https://wikis.ec.europa.eu/display/IMAP/Impacts+of+farming+practices+on+environment+and+climate

9 Andrea Schievano. Available evidence on long-term soil Carbon storage in the field of agricultural science. European Commission, Joint Research Center. Apr 5th, 2023.

10 Wang et al, GCB Bioenergy (2016) **8**, 512-523, doi: 10.1111/gcbb.12266

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13 IPCC Report AR6 WGIII: https://www.ipcc.ch/report/ar6/wg3/downloads/report/IPCC_AR6_WGIII_FullReport.pdf chapter 7.4.3.2 Biochar

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microbiological life and biodiversity in soil, and supporting socio-economic development in rural areas. The area of agricultural soils in Europe that are low in Soil Organic Carbon (SOC) is so large that the European Commission has already been called by the European Court of Auditors[15] to step up its strategy against desertification and land degradation.
Agronomic benefits[16] have been deeply investigated and assessed: these depend on local agro-climatic and pedo-climatic conditions. On average, the more degraded soils are, the more evident the benefits from biochar and other organic amendments. Biochar addition, together with other forms of regenerative agriculture practices (compost, no tillage, cover cropping, use of digestates from farm-scale anaerobic digestion, etc.), are recognized as sustainable agricultural practices in the REDII-Implementing Regulation, thus key elements of a green transition of agriculture, consistent with the Green Deal and the Farm to Fork EU policy. These are co-benefits of CDR obtained through biochar addition in soils, which makes the biochar proposition unique compared to industrial CDR solutions and by far the most doable and cost-effective in both the short and the medium/long-terms.

In addition to its durability in soils, biochar can also be used as a partial replacement for cement in concrete, which is one of the world's highest-emitting hard-to-abate industries. It can add value to concrete by improving strength, soundproofing and thermal insulation while reducing weight[17,18,19]. Incorporated into the concrete matrix, the stored carbon dioxide is permanently sequestered, offsetting C emissions -- and with the potential to transform a formerly high emitting sector into an active carbon sequestration industry. Similarly, using biochar in the steel industry as a carbon source in place of coal can offer additional opportunity for large-scale carbon storage, beyond decarbonizing the process.

These scientific insights in our view require biochar to be considered in what must be a diverse portfolio of climate change mitigation options that must include both emission reductions from fossil energy use, from land use change and management, as well as carbon dioxide removal from the atmosphere.

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