Biochar Methodology Online Workshop

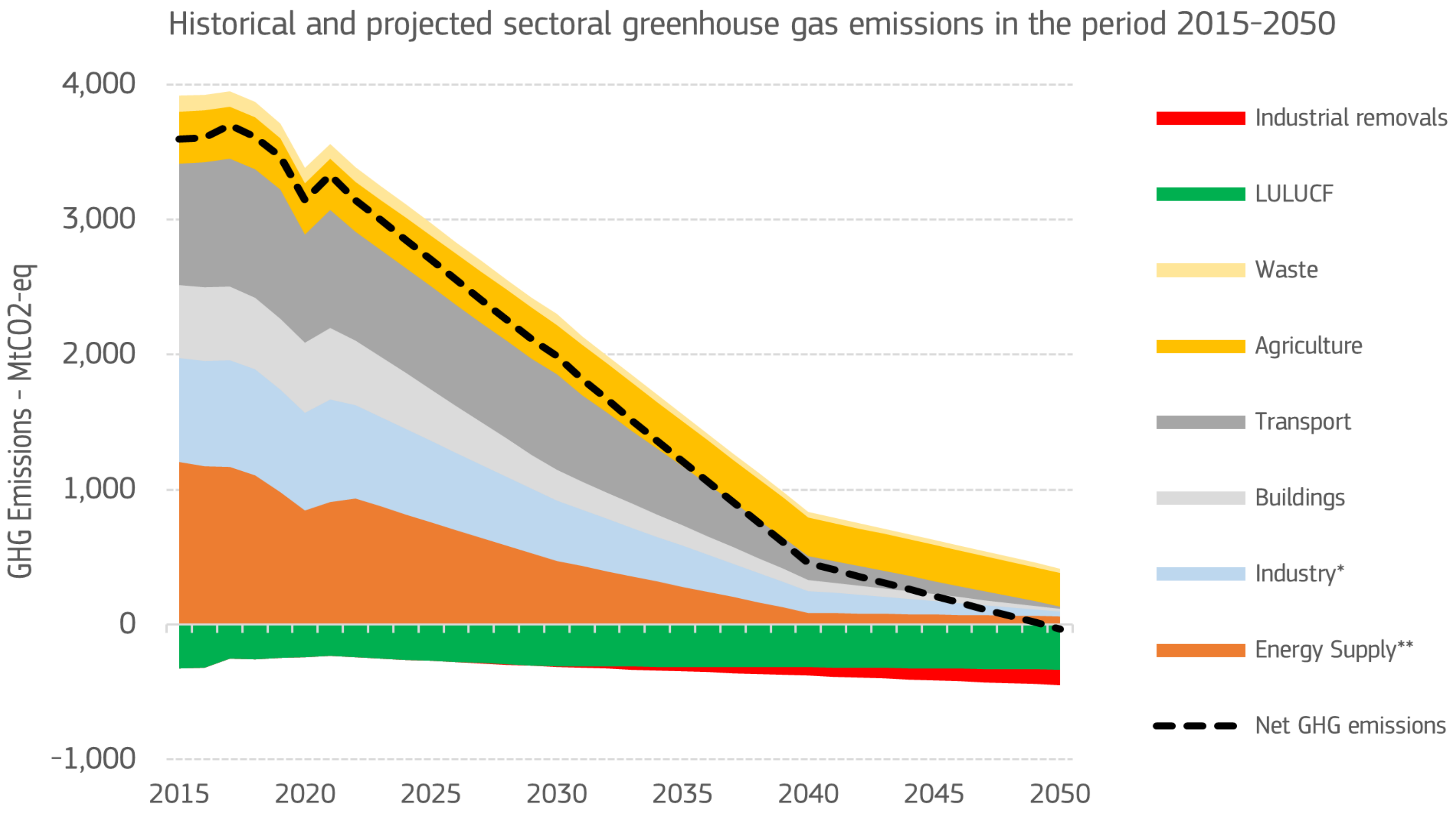
EU Carbon Removal Certification

18 June 2024

Introductory remarks

Christian Holzleitner, DG CLIMA, European Commission

Pathway to climate neutrality



*Excluding non-BECCS industrial removals

**Including bioenergy with carbon capture and storage (BECCS)

90 percent net emissions reduction in 2040
(compared to 1990)

Emissions

Removals

Around 160 Mt emissions from industry

850 Mt

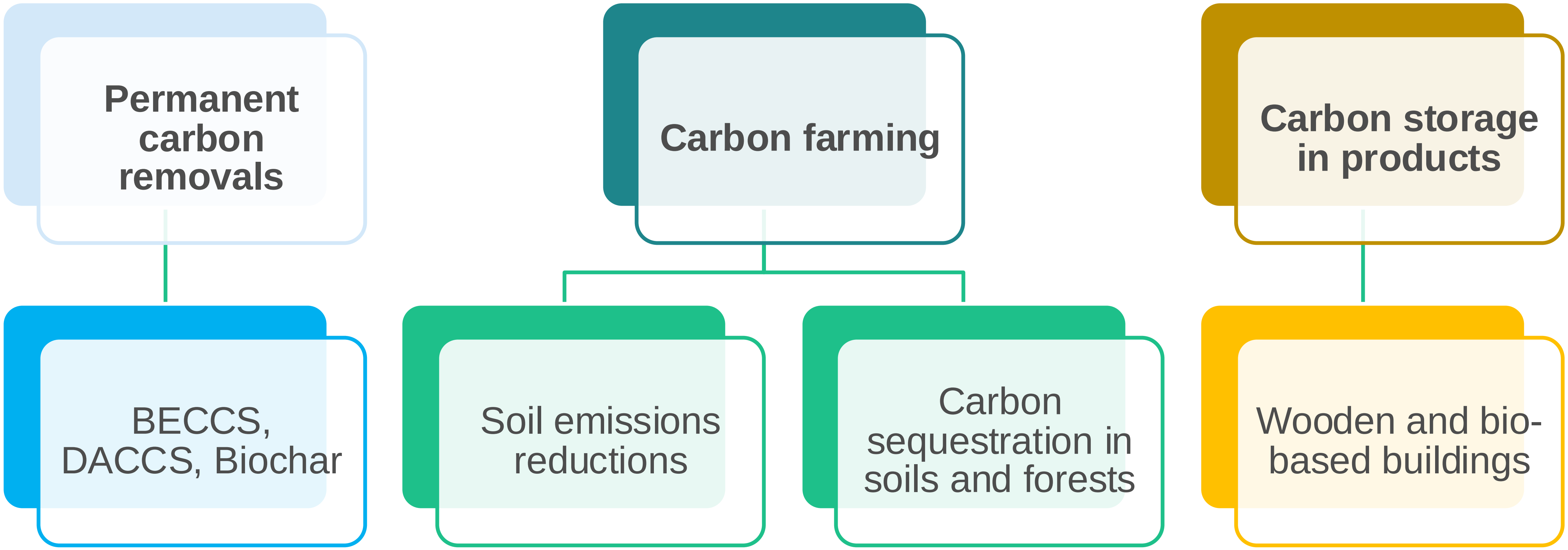
Around **300** Mt emissions from fertilizer and livestock

400 Mt

Around **320** Mt net removals in LULUCF sector

European Commission

Carbon Removal and Carbon Farming Regulation (CRCF Regulation)



How does certification work?

CRCF Regulation

EU certification methodology

QUALITY criteria
- Quantification
- Additionality
- Liability
- **Sustainability**

Commission establishes certification methodologies in consultation with **expert group**

Certification process

Private and public certification schemes recognised by the Commission

Independent certification bodies to issue
- Audit reports
- Certificate of compliance
- **Group audits possible!**

Certification registries and Union-wide CRCF registry from 2028

Publicly accessible information on activities and operators
- Audit reports
- **Certificates of compliance**

Quantity and status of certified units
- Carbon farming sequestration unit
- Soil emissions reduction unit

Key challenges

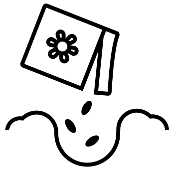
Recognising the long-term storage of carbon in biochar

Storage over **several centuries**, including permanently chemically bound carbon in products

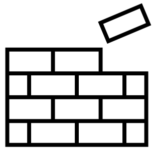
▽

CRCF permanent carbon removal

Looking at different uses of biochar



applied to agricultural soils



incorporated into building materials (concrete, mineral plasters, gypsum, clay)

What's next for the biochar methodology?

June 2024
Biochar online workshop
Technical scoping paper

October 2024
Expert group meeting
Strawman paper

H1 2025
Expert group meeting
Draft methodology

Scene Setter

Review of carbon removal through biochar, Chris Malins, Cerulogy

Support to the development of methodologies for the certification of industrial carbon removals with permanent storage – Review of carbon removals through biochar

18 June 2024

Biochar Methodology Online Workshop, 18 June 2024

ICF in collaboration with Cerulogy and Fraunhofer ISI

Agenda for today

09:30 – Introductory remarks. DG CLIMA

09:45 – Setting the scene, context for the workshop. Chris Malins (Cerulogy)

09:50 – Estimation of long term storage in biochar

- Presentation from the review paper. Chris Malins (Cerulogy)
- Panel discussion
  - Hamed Sanei, Aarhus University
  - Cecilia Sundberg, Swedish University of Agricultural Sciences
- Q&A

11:05 – Break

11:15 – Other issues in relation to certifying permanent carbon removals through biochar

- Presentation from the review paper. Chris Malins (Cerulogy)
- Reactions from expert group members
  - Martin Pigeon (Fern)
  - Amalie Tokkesdal and Julie Marie Deding Nielsen (The Danish Ministry of Climate, Energy and Utilities)
  - Anna Lehner (Carbonfuture)

12:25 – Closing remarks. DG CLIMA

Setting the scene (1)

- Biochar can be produced when biomass is heated in anoxic (low oxygen) conditions, leading to carbonisation of the material (reduction of hydrogen and oxygen content compared to carbon content)
- Carbonisation tends to increase the stability of the material in the environment, so that biochar has a much lower rate of decay/carbon loss than the source biomass
- The characteristics of the produced biochar depend on the temperature and duration of heat treatment and the input biomass feedstock
- The primary method for biochar production is 'slow pyrolysis', generally using temperatures in the range from 350 up to about 1000 °C
- Biochar can also be produced by:
  - Fast pyrolysis, in which case the biochar yield is reduced and the yield of pyrolysis oil is maximised
  - Gasification, a higher-temperature process with a lower biochar yield
  - Hydrothermal carbonisation, a lower-temperature process producing biochars with relatively low permanence

Setting the scene (2)

- It has been demonstrated that biochar can remain stable in the environment for hundreds or thousands of years, depending on its characteristics
- Biochar can be applied in agricultural soils, potentially delivering both carbon storage and agricultural benefits
- Biochar can be incorporated into concrete or other material, potentially affecting the material properties
- Several existing voluntary schemes identify biochar use as a form of carbon removal (the review paper identifies five active certifications)
- The Commission has asked the ICF/Fraunhofer/Cerulogy team to develop a draft certification methodology for permanent carbon removal through biochar
- We aim to present a strawman proposal to the October Expert Group meeting

Estimation of long term carbon storage in biochar

Assessing the permanence of carbon storage in biochar: two approaches

- Applying a decay function
  - Take observations of biochar decay in laboratory conditions (incubation chambers)
  - Use those observations to derive a mathematical formula for expected decay
  - Parameterise function by some combination of:
    - Biochar properties (e.g. H/C_{org} or O/C_{org} – ratio of hydrogen or oxygen atoms to carbon atoms)
    - Process characteristics (e.g. temperature)
    - Feedstock characteristics
    - Environmental characteristics (e.g. soil temperature)
    - Time – estimate remaining carbon after 100/200/300/500/1000/etc. years
- Identifying a fraction of the biochar as having high-durability
  - Test to identify fraction constituted of 'inertinites'

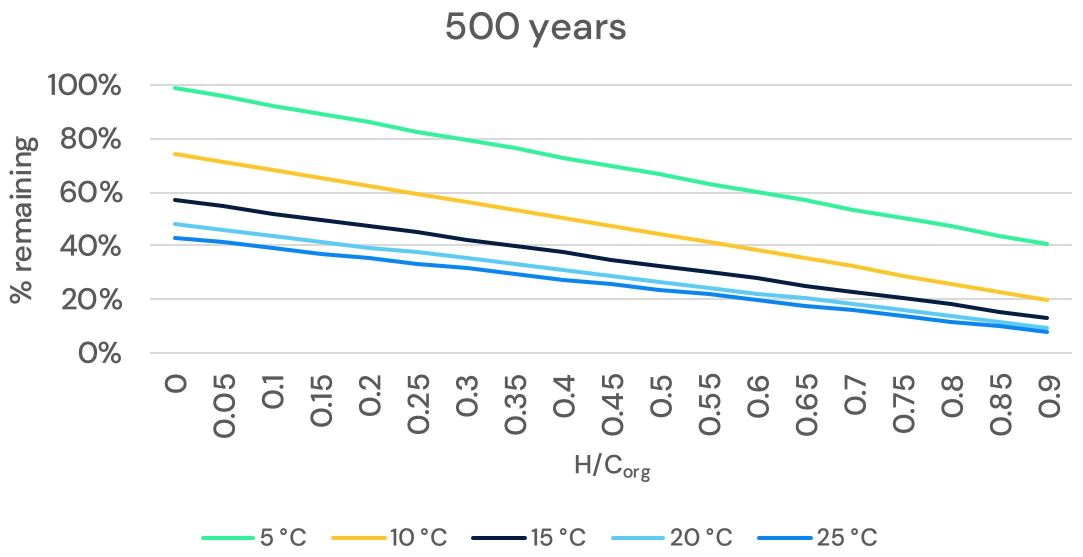
*https://www.ipcc-nggip.iges.or.jp/public/2019rf/pdf/4_Volume4/19R_V4_Ch02_Ap4_Biochar.pdf
†https://pubs.acs.org/doi/full/10.1021/acs.est.1c02425
‡https://www.sciencedirect.com/science/article/pii/S001670612300438X?via%3Dihub

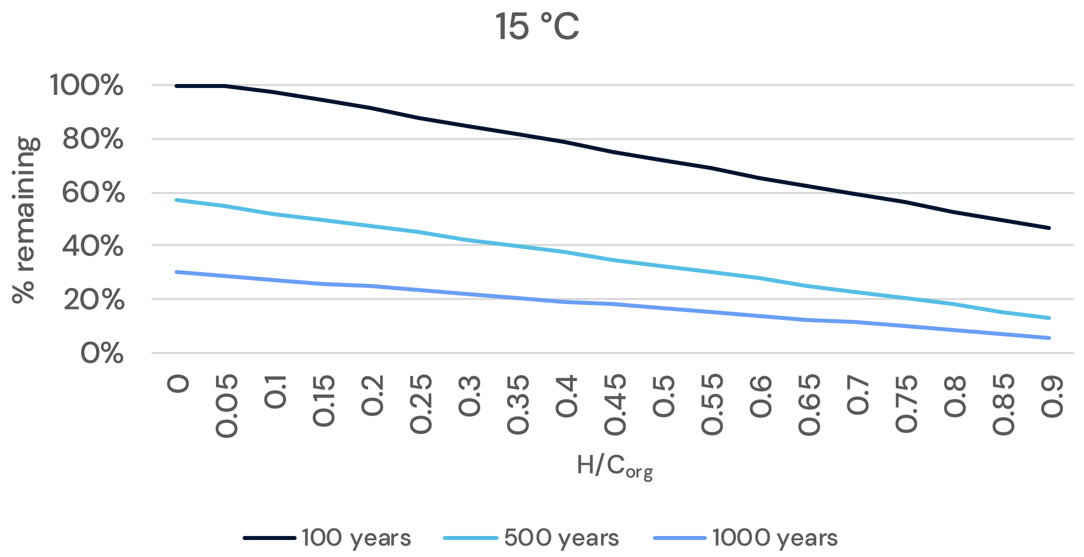
Decay functions – IPCC

- The IPCC published a *‘Method for Estimating the Change in Mineral Soil Organic Carbon Stocks from Biochar Amendments’* as part of the 2019 updates to the national GHG inventory reporting guidelines
  - Based on a two-pool exponential fit to incubation data
  - Calculation parameterised by process temperature T
  - The fraction of carbon remaining after 100 years is defined as:
    - 65% for 350 °C < T < 450 °C
    - 80% for 450 °C < T < 600 °C
    - 89% for T > 600 °C
  - This method is not framed as final but rather as a ‘basis for future methodological development’
  - It is designed as a basis for national reporting of carbon storage in biochar
  - It does not presuppose that the reporting party has access to test the biochar
- Informs permanence assessment in VCS, C-Capsule

Decay functions – Woolf et al. 2021

- Woolf et al. (2021) published decay rate estimates building on the same data as IPCC
- Multi-pool exponential fit to incubation data
- Parameterised by either process temperature (low, high, medium, gasification) or H/C_{org} ratio, plus time (100/500/1000 years) and soil temperature
- Informs permanence assessment in Puro, VCS, Riverse





Decay functions –questions

- Understanding the pools
  - Woolf et al. (2021) and Azzi et al. (2024) use two- or three-pool exponential fits
  - Consistent with biochar being composed of two or three distinct pools, each pool being having a characteristic decay rate
  - For two-pool fits these generally correspond to volatile fraction (~1-2%) with much higher decay rate and remaining fraction (~98-99%)
  - For three-pool fits these seem to correspond to most volatile fraction (~0.5%), somewhat volatile fraction (2%) and remaining fraction (~97-98%)
  - This maths gives no resolution on any differences within the larger, more recalcitrant, part
- Function fitting
  - Different fitting algorithms can give slightly different functions
  - Could use a different function – e.g. a 'power model' treats biochar as if composed of many fractions of increasing greater permanence

Identifying the high durability fraction

- The two-pool and three-pool decay functions from IPPC, Woolf et al. (2021), Azzi et al. (2024) etc. implicitly assume that the whole of a sample of biochar will eventually biodegrade
- An alternative view is presented by Sanei et al. (2024), which notes that many commercial biochars are constituted mostly of 'macerals' comparable to inertinite macerals in coal
  - Inertinites are highly carbonised and aromaticised and are considered
  - In coal, inertinites can be preserved for millions of years
  - It is argued that inertinites can be expected to experience essentially no carbon loss on relevant timescales
- Inertinite content can be assessed by 'R_o reflectance testing' – inertinites have $R_o > 2\%$
- The fraction of a biochar identified as derived from inertinites could be treated as having a zero effective decay rate
  - There is not (yet) consensus on this idea in the academic community

Example

- Consider a biochar with H/C_{org} = 0.2, analysed and shown to consist of 2% volatiles and 98% inertinites
- Permanence assessed based on estimated carbon storage after 500 years in a soil at an average temperature of 10 °C
  - Woolf et al. would give 74% carbon storage
  - Inertinite assessment would give 98% carbon storage
  - A power model based fit would be likely to give > 90% storage
- The differences would be increased for higher soil temperatures

Discussion questions

- Should a biochar certification methodology allow applicants to assess permanence by undertaking R_o reflectance testing and treating the identified inertinite fraction of the biochar ($R_o > 2\%$) as fully inert on relevant timescales?
- Should a biochar certification methodology allow applicants to assess permanence based on a decay function parameterised by the H/C_{org} ratio and the expected ambient temperature of the soil/material?
  - If permanence assessment by decay function is permitted, what time period should be required for the assessment (e.g. 500 years)?
  - If permanence assessment by a decay function is permitted, is there any basis to use different decay functions for soil applications and material applications?

11:05 – 11:15

Break

Session 2. Other issues in relation to certifying carbon removals through biochar

Scene setter, presentation of the Review paper, Chris Malins, Cerulogy

Reactions from Expert Group members and discussion

- Anna Lehner, Carbonfuture (for EBI)
- Martin Pigeon, Fern
- Amalie Tokkesdal and Julie Marie Deding Nielsen, The Danish Ministry of Climate, Energy and Utilities, Denmark

Q&A

Other issues in relation to certifying carbon removals through biochar

Certification for biochar as a carbon removal

- We identified:
  - five standards offering certification of carbon removals through biochar (EBC C-sink; Puro.earth; VCS; Riverse; C-Capsule);
  - one draft standard that was not adopted (ACR);
  - the biochar quality standard of the International Biochar Initiative and the carbon credit rating principles of Sylvera
- The active standards all assess carbon removals based on an estimate of 100 year carbon storage by biochar
  - One reason that the ACR standard was never implemented was disagreement about permanence from the peer review report
- The *EBC Guidelines for a sustainable production of biochar* are widely referenced as governance for biochar production and quality
- Some standards are more limiting on biomass eligibility than the RED rules, e.g. VCS only allows feedstock that is "Biogenic waste biomass and not purpose-grown"
- Standards vary as to whether biochar must be tracked only to the point of sale or whether application in the field must be demonstrated

Issues for discussion identified in the review paper (1)

- Additionality
  - Some standards use an activity penetration test plus regulatory surplus test to justify treating biochar projects as additional
  - The availability of valuable co-products from (some) biochar production also affect consideration of financial additionality
  - Could a standardised baseline of zero be set for (some) biochar projects, or should an activity specific baseline be required?
- Co-product accounting
  - Should $GHG_{associated}$ be calculated using energy-based emissions allocation (as in RED)?

Issues for discussion identified in the review paper (2)

- Demonstration of use
  - Should certification require tracking the use of biochar beyond the point of sale?
  - If tracking to point of sale only, should biochar be required to be sold in a form that makes future combustion impractical?
  - If tracking biochar to the field, should incorporation in soil be a requirement?
- Sustainability and co-benefits
  - Could a GHG co-benefit be defined in relation to using specific biomass resources that minimise the 'carbon payback period' after feedstock collection/harvest (e.g. residues)?
  - Could a co-benefit be defined for biochar application approaches that maximise agronomic benefit?
  - Are the EBC production guidelines a sound basis to manage other sustainability risk (e.g. toxicants)?

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Closing remarks

DG CLIMA, European Commission

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