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CLIMATE ACTION
Directorate C – Innovation for a Low Carbon, Resilient Economy
CLIMA.C.3 – Low Carbon Solutions (III): Land Economy & Carbon Removals

Brussels, 22 December 2023

Minutes
3rd Meeting of the Carbon Removals Expert Group
Industrial Carbon Removals

25 and 26 October 2023, Brussels

1. Approval of the agenda
The agenda of the 3rd meeting was adopted without comments.

2. Set-up of the meeting: 3rd Meeting of the Carbon Removals Expert Group
The third meeting of the Expert Group (EG) took place in a hybrid format, with WebEx available for experts who could not attend in person. The entire meeting was also web-streamed on the Slido platform to allow interaction with the wider public. The recordings of the sessions and the slide decks are available on the Commission Expert Group website.[1]

3. Overview
The agenda of 3rd EG meeting covered three industrial carbon removal topics: methodologies for industrial capture of carbon, methodologies for transport and storage of captured carbon, and methodology architecture. ICF-Cerulogy and CRETA presented their scoping papers, which analysed existing methodologies on permanent removals and biogenic carbon stored in products, respectively, and their high-level alignment with the proposed QU.A.L.ITY criteria. This was complemented by presentations from methodology developers and users, panels and discussions amongst the members of the EG.

The discussions and subsequent written feedback will feed into the development of the technical scoping paper on the existing methodologies that is being prepared by ICF and Cerulogy.

4. Detailed summary of the discussions

OPENING SESSION
Chair: Christian Holzleitner (DG CLIMA)

Welcome and opening
Introduction by Christian Holzleitner - Head of Unit Land economy and carbon removals (DG CLIMA)

[1] https://climate.ec.europa.eu/news-your-voice/events/expert-group-meeting-industrial-carbon-removal-certification-methodologies-2023-10-25_en

DG CLIMA outlined the agenda of the two-day meeting, focussing on identifying existing best practices in the development of certification methodologies for industrial carbon removal and permanent storage in products, discussing uptake factors and socio-economic aspects, and understanding where further research and innovation is needed. The outcome of a recent EU survey on certification methodologies for industrial removals (presented at the meeting) would serve as input for the scoping papers to be finalised later in 2023. DG CLIMA gave a brief overview of the timeline of the work of the EG. The 4th EG meeting will be held in April 2024, and will address: (i) presentation of the final carbon removal certification framework (CRCF) pending the legislative process, (ii) the key findings from the scoping work related to carbon farming, industrial removals & long-lasting storage in products, and (iii) the presentation of the new workstream of the certification processes and rules for the registries. Preferably, it will be held together with the closing conference of the Horizon Europe project Negem, which focusses on negative emissions. First draft certification methodologies should then be presented by the end of 2024 / early 2025.

Keynote address
Importance of robust methodologies for CDR purchases by Rafael Broze, Senior Programme Manager, Carbon Removal, Microsoft

Rafael Broze (Microsoft) gave a perspective on the emerging carbon removal market. Impressed by the work of the Commission and the EG, he stressed the importance to protect licences and encourage investments. Regarding headwinds, Rafael highlighted the public scrutiny on carbon markets in general and the structural complexity. The EG will need to deal with challenges regarding philosophical questions, balancing principles, creating rules for practical approaches that can be easily updated and designing incentives to keep stakeholders working towards removals. In terms of tailwinds, knowledge in this sector is expanding, as the carbon removal market is a growing team with expert advisors, NGO's and experience from early buyers creating knowledge and guidelines. In addition, more MRV groups are emerging with a focus on quality and scale. Overall, methodologies are crucial specifications for novel carbon removal activities, such as BECCS and DACCS. It is therefore relevant for other market players to follow, learn and help standardise best approaches. Time is of the essence, as infrastructure development and innovation are slow, which limit the need for fast-paced upscale to meet the net-zero emission target. The current process between the engineering of proto-design and its effective operation and optimalisation cycles to upscale takes up to 25 years. Early projects are crucial to identify and solve uncertainties and open the way for investments. In this process of methodology development, it comes down to the EG being a good referee, wherein it may be best to start with a broad approach and progressively tighten the methodology as solutions appear. Rafael concluded with areas of risk to address: overcrediting in terms of the actual results from the carbon removal activity and harm to human and environmental health.

Christian Holzleitner (DG CLIMA) remarked that the current regulatory environment that touches upon these issues, including the ETS and electricity market, can help address some of the challenges that were pointed out.

Samantha Tanzer (TU Delft) warned about allowing early-stage projects to generate carbon removal credits when, if approached more rigorously, they would not. Early mover projects could be incentivised with activity-based, rather than results-based incentives, e.g., capital support or innovation fund grants, while we develop and design MRV for these projects. **Rafael Broze** explained that Microsoft focuses on results rather than activities and on properly

measuring those results so that they can be confident in their claims, and emphasised that they rely on existing regulatory structures such as e.g. the CCS Directive with regard to leakage.

Presentation of the technical scoping paper on methodologies for permanent removals by Chris Malins, Cerulogy

Chris Malins (Cerulogy) presented the scoping paper identifying relevant elements of existing policies and standards that methodologies for the certification for industrial carbon removals could build upon as gathered from the survey. Additional feedback from the EG will be used to complement the scoping paper, which now includes the assessment of six relevant methodologies from the existing EU regulatory framework, namely the ETS Directive, the Monitoring and Reporting Regulation, the CCS Directive, the Renewable Energy Directive, the Sustainable Finance Taxonomy, and the Innovation Fund. In addition, 13 methodologies were identified from private standards and non-EU public frameworks, which were analysed on areas of difference on (i) quantification and boundaries, (ii) additionality and baselining, (iii) long-term storage and liability, (iv) sustainability and (v) MRV. The draft version of the scoping paper is only available for the EG to receive input, whereas the final version will be made public.

INDUSTRIAL CAPTURE OF CARBON

Chair: Chris Malins (Cerulogy)

Direct Air Capture (DAC)

Presentation: Direct Air Capture

Louis Uzor (Climeworks) presented the Climeworks DAC methodology using 100% geothermal energy to permanently store CO_2 via mineralisation in their Orca plant in Iceland. The full-chain methodology covers capture via TVS adsorption, transport via pipeline and in-situ storage following a lifecycle assessment (LCA) approach and zero baseline scenario. It is implemented using real and science-based inputs that are metered where possible with internationally standardised emission factors and flexibility to cater to the novelty of DACCS. Climeworks aims to contribute to methodology development via plural projects and by providing the blueprint. The purpose and use is the voluntary carbon market. Three key points for future development include energy sourcing, plural capture sources and additionality assessment.

Comments

Eadbhard Pernot (Clean Air Task Force) pointed out that in terms of MRV, DAC is less challenging than other carbon removal methods. He also aired his concern regarding the upscaling of the energy-intensive technology of DAC, without loosening MRV and application requirements. Although the Orca plant has the benefit of geothermal energy, Europe does not have an unlimited supply of clean energy. There are many types of DAC and with Orca being designed for specific circumstances, the question is whether to aim for a general DAC methodology or multiple tailored ones.

Selene Cobo Gutiérrez (ETH Zurich and Negem) explained that creating dynamic LCAs for different DAC technologies can show the efficiency of the plant and highlighted the importance for consumers to know what they buy. Companies benefit from gaining trust by making results publicly available. While the risk of leakage is deemed minimal, transparency is important, including about how Climeworks monitors for it and who is responsible to prevent it.

Discussion

Louis Uzor (Climeworks) responded that leakage is included in the methodology and that consumers have insight in the amount of CO_2 removed via their website. Having different methodologies for different types of DAC takes time to develop, but indeed has its benefits. He, however, also emphasised the benefits of harmonisation to avoid too complex of an approach.

David Chiaramonti (Type A-expert) asked if the LCA makes a distinction between the injection of CO_2 in basalt (Carbfix) or in a well of an oil plant to enhance oil recovery (EOR). **Louis Uzor (Climeworks)** answered that EOR is explicitly ruled out in the methodology, and that Climeworks is open to other storage approaches, mainly supercritical injections. The current methodology may hint towards those approaches, but is ultimately reflecting the Carbfix approach. **Chris Malins (Cerulogy)** added that in their analysis for the scoping paper they came across a broad consensus that EOR should not be accepted in DAC methodology, including in the Innovation Fund methodology.

Florie Gonsolin (CEFIC) asked about the potential of the technology in terms of the net annual carbon removal and the abatement costs.

Mark Preston Aragonès (Bellona Europe) commented that the end use of the carbon credits (i.e. to counterbalance emissions or quantify emissions) is currently unclear, but is important in how the methodology is devised. He also asked how to ensure that the energy needed to remove carbon from the atmosphere will not impact the energy transition.

Louis Uzor (Climeworks) responded that there is a correlation between technology potential and investment. From the current perspective, the potential is almost unlimited. As long as the voluntary carbon market (VCM) exists the potential of DAC increases. Currently, Climeworks credits are sold for 1.000 US dollars per tonne on the VCM, and Louis expressed content that other financing options are increasingly discussed.

A question from the **SLIDO** platform enquired if it is fair to characterise the methodology development as a process of trial and error.

A question from the **SLIDO** platform enquired if DAC contributes to the SDGs.

Olivier Kassi (Belgium) asked how much energy in kW/h is required to store 1 tonne of CO_2.

Wijnand Stoefs (Carbon Market Watch) wondered how replicable the Orca methodology is due to its access to geothermal energy and if it will create positive emissions when the required energy is obtained from the electrical grid.

Louis Uzor (Climeworks) confirmed that DAC contributes to SDGs, namely SDG 13 climate change but also through job creation. He further responded that Climeworks uses trial and error to obtain learnings to improve the methodology. On energy requirements, Louis responded that they are substantial, with 2.000 kWh per tonne possible in Iceland, while the first plant in Zurich measured 4.000 kWh per tonne. These energy questions should be incorporated in methodologies, but there are useful precedents that we can build on, e.g. the hydrogen

additionality. However, where environmental integrity is too stringent, the cost of the project will increase, requiring even greater financing.

Eadbhard Pernot (Clean Air Task Force) cautioned about drawing an analogy between green hydrogen and DAC, because in Europe hydrogen is needed as an energy carrier in different sectors, while in his view DAC is not as important a lever in climate mitigation. He repeated a previous comment that for designing a methodology it is important to know its end use.

Robert Höglund (Type A expert) commented that during the build-up phase of carbon removal, we will need to accept that it is not the best use of energy. Large scale DAC does not make sense until the electricity grid is decarbonised, but scaling up DAC cannot wait.

Samantha Tanzer (TU Delft) asked what buffer or correction mechanisms are in place in the Climeworks methodology to deal with uncertainties regarding the quantities of removal planned versus delivered.

Veronika Elgart (Swiss Environment Office) asked what specific requirements for additionality should be included in the methodology and how can these be evaluated to create transparency. The Orca DAC methodology allows for accurate quantification to transform into credits, but the methodology needs more transparency and clarification regarding for potential end use(rs) for the purpose of integrity, usefulness and foreign investment.

Martin Cames (Type A expert) agreed on the need to have a clear understanding of the end use of the credits in order to incorporate an appropriate level of stringency in the methodologies. He also asserted that, based on the experience of the Clean Development Mechanism (CDM) over the last 20 years, it may be appropriate to have one methodology that covers multiple (activity-based) approaches instead of project-specific methodologies. Finally, he asked what would be the gross net amount of carbon units that the Orca plant get from the methodology, and which processes are the most carbon intensive.

Louis Uzor (Climeworks) responded to Samantha Tanzer that for Orca there are no uncertainties in measurements, but in a next project there could be due to technological changes. Relatedly, and regarding the question of Martin Cames, it is better to have activity-specific tools and harmonise them into one methodology, but this requires time. Finally, Louis emphasised that the market for CDM projects is distinct from the market for carbon removal projects.

Eadbhard Pernot (Clean Air Task Force) stated that accountability for uncertainties is more of a policy design than methodology question. He expressed his concern that mega-scale DAC or BECCS projects may lose sight of the IPCC climate change target and force the methodologies to fit the market for offsetting and marketing purposes.

Kristin Jordal (Zero Emissions Platform and CINTEF) commented that emission reductions are needed at a larger scale than removals and, e.g., if there is an amount of waste energy available in a certain industry (that you would use for DAC), you could use it to capture the emissions from that industry instead. She also inquired what the fraction of CO_2 emissions from the production and materials for the DAC plant is compared to the carbon it removes.

Zoltán Szabó (ClonBio) enquired about the cost expectations of DAC in 2030 and the market competitors.

Fabian Levihn (Stockholm Exergi) commented that energy recovered during the DAC process, for instance heat, should also be taken into account. In addition, the methodology should be able to be used by corporations to counterbalance their residual emissions, which comes back to the topic of end uses in the CRCF.

Louis Uzor (Climeworks) answered that the cost perspective is currently 1.000 US dollars per tonne but is expected to decrease to 300-600 US dollars by 2030 due to technological innovations. However, if the methodology is too stringent and the only use case is the voluntary market that wants it to be less expensive, then there will be no more learnings through new deployment that would bring down the cost. The ratio between production emissions and carbon removals are correlated to plant lifetime and deemed negligible when maximised.

Eadbhard Pernot (Clean Air Task Force) argued that he could not think of companies that currently have residual emissions that need offsetting, although it may become a problem in the future. The target for DAC in the US is to get the price below 100 dollars per tonne, however, no policy targets are currently present.

Chris Malins (Cerulogy) asked questions regarding the circumstances in which a non-zero baseline should be set in a DAC project and if anyone saw a case to limit recertification.

Eli Mitchell-Larson (Carbon Gap) pointed out that there are elements in the methodology that do invoke the use cases, for instance regarding the specifications of the transportation and storage, and the fact that e.g., PURO makes considerations regarding the provider and buyer of carbon credits. Current buyers tend to compensate their emissions, not contribute to removal goals. However, incorporating that requirement in the contract with the buyer may set an important precedent that other removal methods will follow.

Samantha Tanzer (TU Delft) required justification for the claim that emissions from the Orca project are negligible and there are no uncertainties in the measurement of net carbon removals.

Iain Macdonald (IOGP) pondered if DAC should be categorised to be on the positivity list and if so, what this means for additionality and the drive behind DAC projects.

Olivier Kessi (Belgium) argued that it is impossible to predict future costs, but that the technology will indeed improve, therefore the absolute cost will decrease. Also, whatever the use of the methodology, it should be stringent to avoid less removals than emissions.

Chris Malins (Cerulogy) highlighted that the positivity list is a functional equivalent to a zero-baseline with the baseline-based additionality.

Louis Uzor (Climeworks) pointed out that technological improvements will not happen by themselves, but by repetition, and wherein a balance needs to be found between the requirements of environmental integrity and the goals for removals projects.

Eadbhard Pernot (Clean Air Task Force) agreed to have a clear idea of the goals and target, otherwise the methodology will not fit the overall needs of the climate. There is much to learn from DAC projects, with the DAC methodology of Orca as a good first attempt. Many controversial issues are more to do with policy design rather than the methodology itself. Methodologies should not be the only lever for improving DAC projects.

Selene Cobo Gutiérrez (ETH Zurich and Negem) answered that the uncertainty for the Orca project lies in the assumptions regarding the LCA. Climeworks is still young, therefore uncertainties are still acceptable at this stage. A future contingency plan for leakage is necessary. Finally, setting separate targets for removals and reductions is desirable.

Bioenergy with Carbon Capture

Presentation: a BECCS methodology

Johan Börje (Stockholm Exergi) presented SE's modular methodology with retrofit baseline for measuring net CO_2 removal through BECCS with the aim of capturing 800.000 tonnes of CO_2 per year. As there was no clear consolidated methodology for BECCS to make credible claims, they developed their own using ISO standards and EU legislation and projects. The current feedstock is sustainably sourced forest biomass with the aim of expanding to agricultural biomass, as well as waste incineration in 2024. Five principles are used to justify the absence of a buffer, and MRV is done by a third party.

Comments

Fabio Poretti (CEWEP) explained how waste from municipalities and industries is converted to energy. Around 60% is biogenic. Emissions may be improved with BECCS technology and the sector is currently looking into CCS opportunities. The Exergi methodology could be adapted to include waste, although three points need to be considered: 1) the feedstock of waste incineration is paid and has environmental benefits, 2) the type of CO_2 from waste is terrigenous but can be accounted for using radiocarbon analysis techniques, 3) MRV techniques. Common points include the assessments for transportation, leakage and risk of reversal.

Samantha Tanzer (TU Delft) said that, in general, the BECCS methodology is working against the current limits of the LCA. There is a need to avoid perverse consequences of the methodology, where removals lead to increases of emissions. 'Conventional' does not mean the best solution: there is a need to be critical and improve or change where necessary. The methodology should be conservative and include leakage, a buffer and displaced emissions, wherein removals should present the sum of CO_2 removed and emissions that occur during the process. Reductions remain a focal point and should never be treated the same as removals.

Discussion

Johan Börje (Stockholm Exergi) responded that the ambition of the SE methodology is to contribute to 'modularity' - where the methods for, e.g. calculating baselines, quantification or additionality, are set out and specificities of a method can then be summarised in an annex. On waste, he highlighted that we need to be cautious about the origin of waste and if all waste is a legitimate product on the market. In response to Samantha Tanzer, he said that leakage is deemed indirect emission and should not be confused with reversal from storage.

Jean-Francois Soussana (INRAE) asked how the forest biomass is taken into account, as climate change will not allow for the same level of biomass in the future. He inquired if the variation of soil carbon stocks is taken into account in the methodology as a part of long-term carbon storage in forests, and how the indirect land use effects of energy crops is looked at.

Zoltán Szabó (ClonBio) informed the expert group that their organisation collectively emits 500.000 tonnes of 99% clean biogenic CO_2 into the atmosphere each year. He argued that the

process of fermentation deserves its own methodology. As such, they are ready to invest in CCS and took this opportunity to explain their interest.

Morten Skovgaard Olsen (Danish Energy Agency) agreed that it's important to avoid having too many methodologies and therefore to have waste-to-energy covered by a BECCS methodology. He wondered if REDIII is sufficient and applicable as to sustainable biomass.

Eric Fee (Germany) asked how to guarantee the sourcing of biomass from areas with increasing carbon stock (as set out in the SE methodology) and how to consider annual fluctuations.

Florie Gonsolin (CEFIC) asked how the relevant methodologies that cover process emissions, such as from the use of biomass for the production of hydrogen, as opposed to energy conversion emissions, are covered in the scoping paper. She also inquired about the relevance of certificates for industrial producers that undertake activities on their own sites to reduce their own emissions.

Chris Malins (Cerulogy) responded that methodologies exist that include methane for hydrogen production as well as biogenic CO_2, the latter of which is not yet included in the scoping paper.

Johan Börje (Stockholm Exergi) clarified that they can only claim a removal in case the carbon stock they source biomass from is stable or increasing, otherwise it is a reduction. Using measurement data should show if the carbon stock is positive and can be sourced or negative, in which case they move out of the area. In the methodology, forest land is coupled with harvested wood products (HWP). The methodology is applicable to removals with geological storage, even fermentation, in which case specifications can be added as annex as long as the feedstock is up to the standard. The application of REDIII is clarified in the methodology.

Fabio Poretti (CEWEP) explained that there is an advantage in capturing emissions from waste-to-energy, as it not only generates removals from the biogenic parts of the waste but also reduces fossil emissions (however, these are reductions, not removals). REDIII excludes waste from its criteria.

Samantha Tanzer (TU Delft) stressed the importance of counting the carbon and incentivising behaviour with BECCS projects. CO_2 emissions should be minimised and not ignored in the value chain. The upstream emissions of waste are uncertain. Waste-to-energy only functions well in coordination with other waste policies.

Chris Malins (Cerulogy) asked for the views of the expert group on constructing new facilities with CCS vs. retrofitting existing ones such as fermentation plants, and if this changes the perspectives on baseline and assessment of the sustainability of biomass resources.

Louis Uzor (Climeworks) agreed that regulatory additionality should be assessed to respect the polluter pays principle, but from the perspective of the project developer, it's important to state explicitly that even if a binding NDC target is set for removals, it doesn't mean regulatory additionality is not there. Regarding funding, carbon contracts for difference are already used for various clean technologies, however in terms of policy context it creates an exposed analysis of additionality that will be extremely hard for project developers due to FIDs and ex-ante assessments. Regarding crediting period, Louis wondered why SE chose 15 years, twice

renewable. Finally, in terms of baseline-setting, he pointed out that there are different baselines in one single technology for different projects, which should be taken into account if we are to create a level playing field for funding CDR.

Fabian Levihn (Stockholm Exergi) agreed that BECCS is not only about generating energy and that the methodology should allow for the use of different feedstocks. In addition, it's about optimising the recovery of energy from the process to reuse and increase the outputs.

Elisa Martelucci (ECOS) raised her concern regarding ISO standards used in the BECCS methodology that are outdated in respect to the latest scientific developments on removals and are about to be reviewed. ISO 14060 does not include sustainability, the responsibility and actions for reversals are not addressed, and removals are not aggregated to sink type.

Morten Skovgaard Olsen (Danish Energy Agency) wondered if Exergi's methodology rules on the sustainable use of biomass would be applicable to all types of biomass, as the demand of biomass for energy will increase with only a small fraction used for BECCS.

Johan Börje (Stockholm Exergi) responded that an NDC does not necessarily imply regulatory forcing, there may not be a mandate imposed on operators to fulfil the NDC. If that is not the common view, it should be addressed. Regarding funding, the methodology allows for government aid schemes if participation and investments from the VCM will reduce the burden on the taxpayer. On why the projects are credited for 15 years, **Johan Börje** stated that this is indeed harmonisation with the UNFCCC work on Article 6. On the ISO question, he responded that ISO can provide a structure, whereas they refer to RED for sustainability and the combination of the CCS Directive and the ETS Directive for liability. The 'not distinguishing between the sink type' is not necessarily relevant. Regarding sustainability, the methodology does not invent anything new but relies on contemporary environmental policies in order to run a sustainable BECCS plant.

Samantha Tanzer (TU Delft) made the point that displaced emissions are a reduction from the baseline and should be excluded from the calculation for physical net removals. On the zero rating of biomass in the BECCS methodology, she stated that territorial accounting (annual accounting for a nation) should not be confused with project-based accounting.

Johan Börje (Stockholm Exergi) responded that if you can recover energy in the process then the project ends up with zero energy penalty in the district heating. Indeed, the limits of LCA and methodologies are being reached, so new accounting schemes are needed to get the industry going.

A question from the **SLIDO** platform asked how imported biomass can be considered sustainable given long-distance shipping of resources.

Chris Malins (Cerulogy) responded that shipping emissions are generally significantly lower than the potential carbon capture benefits.

Hardo Becker (European State Forest Association) wondered how LULUCF will account for the carbon capture of biomass after heating.

David Chiaramonti (Type A-expert) pointed out the illogical practice of making carbon via biomass, only to then burn it and capture the CO_2 again. Instead, David argued to continue the

process to burn the volatile part of the biomass to deliver energy and capture CO_2, but also capture the leftover carbon as a solid component (biochar).

Jean-Francois Soussana (INRAE) urged to work towards one framework for DACCS and BECCS with harmonised, comprehensive calculations and system boundaries for the different techniques.

Wijnand Stoefs (Carbon Market Watch) shared six comments: the methodology should not simply adopt the convention of zero rating all biomass; from a climate perspective, forest biomass is only beneficial when restored, otherwise it constitutes a shift in product but this is not shown in the methodology; sustainability risks should be included in the methodology; as well as social impacts such as land loss; the additionality test points to double-counting; and finally, he considers VCM a greenwashing instrument.

Johan Börje (Stockholm Exergi) stood by the current design of the plant with the main focus on capturing carbon. Ashes are returned to the forest location to enhance the carbon sink and sustainability risks are taken into account via stable or increasing carbon stock. Double-counting between stakeholders is avoided, but co-claims are welcomed to reduce the burden on taxpayers. By setting separate targets for reductions and removals by governments, there would be no issues with accounting, reporting and claiming.

Fabio Poretti (CEWEP) clarified that there is a difference between waste and a product, wherein waste has a negative value and has no competition from recycling. Only products that cannot be recycled should be turned into waste. Landfills pollute the environment and produce methane, contrary to thermal treatment of waste which can recover energy, as shown by the full picture of the life cycle.

Samantha Tanzer (TU Delft) concluded that it is best for the EG to come up with general principles to ensure that we have the same strict standards for high quality removals, and then hashing out the accounting details. She stated that BECCS is not a decarbonisation technology, but a carbon intensive form. Therefore, it needs to be clear how much carbon is in the system regarding (displaced and avoided) emissions and storage as well as in total to ensure high efficiency of removals. Finally, conservative attitude requires leaving room for unknowns.

TRANSPORT AND STORAGE OF CAPTURED CARBON

Chair: Laura Sales Pereira (ICF)

Transport and geological storage

Presentation: CCS Directive

Christian Heller (Umweltbundesamt) presented the monitoring rules for CCS in the EU ETS and their revision as part of the Fit-for-55 package. General principles of the EU ETS mandate that covered installations only report direct emissions and obtain a GHG permit and approved monitoring plan. The EU ETS covers the capture of CO_2 from installations for the purpose of its transport and geological storage in sites permitted by the CCS Directive. The legal framework covers permanence and reversal risks. Rules in the Monitoring and Reporting Regulation (MRR) under development include the accounting order of capture, CO_2 transport emissions and activity emissions. The update of the MRR is planned for Q2 of 2024.

Comments

Thomas Ratouis (Carbfix) explained their experience with the CCS Directive. The Carbfix approach injects CO_2 into the subsurface, where natural processes form carbonate minerals, and is covered by the CCS Directive without requiring a CCS permit. Although the CCS Directive covers safe storage of CO_2, it is focused on an older supercritical injection approach, which requires a cap rock to prevent leaks. This is one of the issues currently addressed by the Commission with a review of the Directive's guidance documents. The CCS and GS Directives are a useful structure that avoids regular legislative updates. However, currently the ETS applies to transport and storage of CO_2 from non-ETS-sources, which unfairly exposes non-ETS installations to ETS penalties. Finally, permanence should be well defined.

Morten Skovgaard Olsen (Danish Energy Agency) explained that Denmark has a five billion Euros subsidy scheme for CCS in hard to abate sectors and for negative emissions. The first 20-year contract was awarded to Ørsted in May 2023, wherein at least 400.000 tonnes of carbon will be reduced or removed per year as of 2026. A part of the financing is provided by the sale of carbon credits to Microsoft. Other countries are also preparing or have subsidy schemes. A modular market is anticipated with different operators running capture, transport and storage. A commercial contract needs to include proper accounting and monitoring, including losses, at the handover joints between the different parts of the value chain also because the credits that will be sold will be from the capture side, while several guidelines state that the subtraction of emissions is to take place at the emission site once permanently stored. In addition, it is important to distinguish between CO_2 sources during transport for calculation. Finally, project boundaries and baselines need to be defined, therefore guidelines are urgently needed.

Discussion

Eadbhard Pernot (Clean Air Task Force) raised his concern about exempting a cap rock requirement, which should act as an insurance policy against leakage, also with regard to guarantees for business investments. In addition, the water/CO_2 ratio of 25:1 in injections does not seem overwhelming. **Thomas Ratouis (Carbfix)** responded that the Commission is updating the guidance document to clarify that the ratio is indeed overwhelming, although the presence of pollutants or other gases may not be included. As dissolved CO_2 has no buoyancy drive and transforms into minerals with accurate monitoring via drilling in the reservoir, cap rock does not serve a purpose and is therefore an obsolete requirement.

A question from the **SLIDO** platform by Jos Cozijnsen enquired that if biomass CO_2 is part of ETS and stored compliant to ETS and the CCS Directive, will it get extra EU allowances, or if it is possible to use removal credits for the ETS plant. **Adrian Nicolae (DG CLIMA)** answered that this relates to negative emissions in the ETS, which is currently not possible under the ETS framework as these emissions are zero-rated regardless of if the CO_2 is captured.

Kirstin Jordal (SINTEF) noted that CO_2 emissions were subtracted at the site once stored and wondered if there is a time delay from when the capture occurs before the carbon credit can be sold. **Christian Heller (Umweltbundesamt)** responded that there is always a time delay, especially if the reporting is only done once per year. Liability shifts to the operator during transportation. If sold prematurely, there is no guarantee for the credit, as the quantity of CO_2 actually stored still needs to be validated. **Morten Skovgaard Olsen (Danish Energy Agency)** added that it also depends on whether the buyer believes in the robustness of the monitoring system and the operator is trusted to deliver the carbon that is stated in the contract. For fossil CCS, it can only be subtracted in ETS once storage has been achieved.

Johan Börje (Stockholm Exergi) intervened to explain that in the SE BECCS methodology, leakage is not calculated during transportation for the gross to net calculation due to boil off, which cannot be calculated in the net removal. For the cash flow, certificates need to be awarded on a monthly basis and therefore effectively sold in advance through contracting, but the delivery and payment run parallel to the storage time. **Christian Heller (Umweltbundesamt)** responded that when the credit is bought prematurely, it costs the ETS price but only holds the certification that is validated afterwards. Therefore, the transport operator should be accountable for the difference due to leakage.

Adrian Nicolae (DG CLIMA) explained that the complex elements that are required for the development of the methodology are not considered in the current ETS context. However, the ETS monitoring system will be amended in 2024. For the methodology development we base ourselves on the ETS Directive as it currently is.

Chris Malins (Cerulogy) wondered how Johan's version of a net to gross calculation looks like in a more complex system of infrastructure. **Johan Börje (Stockholm Exergi)** responded that if the calculation of removal starts at the start of transport, it is uncertain how fugitive emissions should be considered with respect to removals. Customers would not consider it acceptable to sell fugitive emissions as part of the removal. The liability structure of the ETS can exist in parallel with a simplified leakage accounting view (the transport company would remain responsible for fugitive emissions in transport).

Christian Heller (Umweltbundesamt) pointed out that when biomass is combusted in a bioenergy plant and CO_2 is released, this is zero-rated and no reporting is required. However, in case of BECCS, if the pipelines for CO_2 transportation fails leading to zero storage, the operator would have to report this as emissions. **Johan Börje (Stockholm Exergi)** agreed that no one wants to buy a removal that does not account for the portion that has already been emitted before it goes into geological storage. Currently, fugitive emissions during transportation account for 0,5 to 1,5%. **Christian Heller (Umweltbundesamt)** accepted, from the environmental perspective, the SE approach of only issuing credits once the removal is actually stored, but stressed that there is, in this case, a risk of double deducting.

Harald Bier (EBI) enquired how biochar could fit into the geological framework.

A question from the **SLIDO** platform enquired about the practical possibility of categorising biochar as permanent storage.

Fabian Levihn (Stockholm Exergi) stated that there is a need to keep track of gross removals as recorded in national inventory versus net removals that you would be able to sell in a VCM. **Christian Heller (Umweltbundesamt)** pointed out that a downstream leakage needs to be paid for, the cost of which must be added to the removal calculation by increasing the price. Regarding biochar, if it is produced by pyrolysis, it is never converted into CO_2 and the ETS would not cover it (even if it did, it would be zero-rated as is the case with bioenergy).

A question from the **SLIDO** platform enquired how the credits purchased by Microsoft within the Danish target are additional. **Morten Skovgaard Olsen (Danish Energy Agency)** responded that if Microsoft had not bought the credits, there would not have been a business case for the project. **Robert Hoglund (Type A expert)** countered that these credits may lead to Microsoft not taking climate action if they have seemingly reached their target.

Samantha Tanzer (TU Delft) enquired how the MRR and the CCS Directive should be included in the CRCF methodologies, e.g. as a minimum standard. **Christian Heller (Umweltbundesamt)** answered that the MRR provides a blueprint for measurement in cases where a source or sink is not already covered by ETS. **Samantha Tanzer (TU Delft)** asked about the uncertainty allowances on small projects that seem relatively high. **Christian Heller (Umweltbundesamt)** assured that the overall realised uncertainty will even out to be much lower than 7,5%.

Mark Preston Aragonès (Bellona Europe) asked if the liability mechanism set out in the CCS Directive, where ETS allowances must be surrendered, could be applicable to other types of permanent storage, such as biochar. **Christian Heller (Umweltbundesamt)** responded that in the case of leakage in storage, the storage operator is responsible. The Commission is currently conducting a study about carbon pricing in agriculture, so some day a farmer might be liable, under an ETS for agriculture, for reversal of biochar stored in soil and accounted for as an emission in his annual reporting. **Mark Preston Aragonès (Bellona Europe)** continued by asking if the requirements for permanence of storage in the CCS Directive could be applicable to other types of storage. **Christian Heller (Umweltbundesamt)** responded that this is a political choice, but that achieving the same level of stringency on the reversal risks liability as in the CCS Directive for other storage types may be challenging. He invited a broader discussion of what is feasible in that regard.

Thomas Ratouis (Carbfix) concluded by reiterating his point on double penalty, where any capture outside of ETS is not incentivised by the CCS Directive, but a penalty is issued for any leakage during the storage phase. However, it would be good to support other carbon sources and add some form of provision to avoid imposing the costs of ETS credits. **Morten Skovgaard Olsen (Danish Energy Agency)** called for focusing on the essentials for the development of the methodologies, not the details.

Chris Malins (Cerulogy) wondered if there is a risk of relying on ETS for liability and creating a scenario in which CO_2 entering a transport system is counted as a removal and receives a carbon removals price but CO_2 leaking from that system is held liable at a lower ETS price, with the effect that CO_2 leakage would become profitable. **Adrian Nicolae (DG CLIMA)** commented that in such a case, a reversal identification at the ETS penalty may not necessarily be appropriate. ETS provides a harmonised treatment for MRV and price. It is possible that the removals methodology could include some additional form of liability management given the issue of the price differential.

Thomas Ratouis (Carbfix) reminded that the customer will not want to pay for a removal that has already been leaked, in which case they are asked to pay for ETS allowances on top. There is also the question of timescales for monitoring.

Morten Skovgaard Olsen (Danish Energy Agency) clarified that the DEA is the customer (subsidy provider) and in its contracts it requires that permanent storage be demonstrated before subsidy is paid out.

Christian Heller (Umweltbundesamt) concluded on the arbitrage issue, where the idea of assessing the amount of stored carbon works well with a linear 1-to-1 relationship, but in a multi-party system there will be some degree of uncertainty and some arbitrage risk.

METHODOLOGY ARCHITECTURE

Chair: Fabien Ramos (DG CLIMA)

Methodology architecture

Presentation: CCS+ Initiative

Christiaan Gevers Deynoot (CCS+ Initiative) presented the CCS+ Initiative's innovative architecture for resilient carbon accounting methodologies. He emphasised that the CRCF should reduce proliferation of methodologies and encourage standardisation. The end goal of methodologies is to allow the market to develop trust in reported removals. The CCS+ Initiative protocol separately accounts for reductions and removals with multiple standards for storage types using various modules, plus overarching requirements inherited from Verra and registry requirements (e.g. differentiated labelling). The Initiative is producing guidelines as a public good to be used in other standards. There may also be an opportunity to use the CCS+ framework to underpin national carbon market instruments or for national accounting under Article 6. Eventually, the protocol should cater to clusters of projects as the unity for crediting. The complexity is already being tested in a Swiss project involving both reductions and removals and multiple transportation modes, transport across EU/non-EU borders and interaction with multiple carbon markets. There is a multiplication of markets that ought to connect to each other. The high quality work that is in progress or already delivered should be the foundation for the CRCF methodologies.

Comments

Eli Mitchell Larson (Carbon Gap) commented that the CRCF must not become irrelevant by moving slower than the ecosystem of climate solutions that it's attempting to certify. Instead, there must be a balance between practicality and stringency. Modularity is an important design principle, however, the question is - and one that participants kept coming to today - how small the modules should be. It may be attractive to use some type of a flow chart methodology. Modularity also helps with the efficiency of review. The Commission must evaluate the methodologies and set up an external review function, wherein external researchers are encouraged to assess ex-ante assumptions and ex-post analysis of delivered carbon fluxes. Three things can be standardised across all modules, namely the verification confidence level (e.g. uncertainty), which requirements are arbitrary thresholds that don't relate to physical flows (e.g. corruption index), and the reversal risks. An important goal for these systems is transparency and a 'quality flywheel'. We need the data collected to feed back and improve the methodologies. Clients will come for the EU brand but stay for the capacity to accelerate climate solutions.

Discussion

Elisabeth Harding (Negative Emissions Platform) shared that she is also in favour of the modular approach, but recognises the intricacies of different removals. Furthermore, the use of the methodologies remains unclear in the legislative proposal and should be clarified. Finally, the Commission needs to be clear on whether it intends to develop its own methodology or would choose from the existing ones. The latter case is preferred to avoid duplication of efforts.

Giulia Stellari (Type A expert) enquired how the architecture can support quality assessment of methodologies and what that would look like. **Christiaan Gevers Deynoot (CCS+ Initiative)** answered that every methodology has a public consultation and is assessed by an independent validation/verification body. All methodologies in the public realm can be scrutinised and feedback can be given. This is baked into the processes for methodology development and implementation. Regarding the flywheel, methodologies should be kept 'evergreen' but we can have different vintages of methodologies. There can be modularity on

design elements that reflect different levels of stringency. Regarding standardisation, eligibility rules and verification confidence levels could sit above a specific methodology. At the methodology level there might be other aspects that can be standardised. At the modular level there has to be some standardisation (e.g. use cases within DAC). Finally, the Commission doesn't have to reinvent the wheel. **Eli Mitchell Larson (Carbon Gap)** expanded on verification confidence levels, where the level will determine whether it is appropriate to use a removal to offset an emission. There needs to be both an on-ramp and an off-ramp for measures – 'don't say no, say not unless' (e.g. alkalinity assessment). The question is what knowledge is needed before a measure hits a level of confidence considered acceptable for offsetting. This is needed quickly as well to prove or disprove climate solutions.

Fabien Ramos (DG CLIMA) responded that the Commission will develop the methodology for carbon removal, but in concert with the current discussion and building on what works well in other contexts. The Commission must guarantee the robustness.

Louis Uzor (Climeworks) commented on the use of modularity across and within methodologies. The Commission proposal states that the intended use is the VCM. However, within the VCM Article 6 is discussed to be ready in a few years. Perhaps the 'buffer' could be part of the Article 6 framework rather than in individual methodologies. **Fabien Ramos (DG CLIMA)** responded that the proposal is not 'for VCM', but a framework for voluntary certification. VCM may be one purpose but is not the only or main purpose. The framework should work in a variety of contexts, perhaps with modules that are relevant for different uses.

Samantha Tanzer (TU Delft) wondered what happens when methodologies are no longer of use and if their numbers increase indefinitely. **Eli Mitchell Larson (Carbon Gap)** explained that methodologies have already 'died out'. The Commission can help with (dis)proving viability.

Oscar Rueda (CCS+ Initiative) mentioned that he compared the CRCF with the CCS+ and produced a type of double benchmarking. In some respects, CCS+ goes beyond the CRCF. The CCS+ is intended for VCM, but in principle applicable to other purposes.

Christiaan Gevers Deynoot (CCS+ Initiative) agreed that it is incumbent on the Commission to clarify the uses of the methodologies it intends to deliver. Without knowing the uses, these methodologies may not be fit for purpose.

LONG TERM STORAGE OF CAPTURED CARBON

Chair: Fabien Ramos (DG CLIMA)

Storing carbon in biochar

Presentation: a biochar methodology

Marianne Tikkanen (Puro.earth) highlighted biochar as one of Puro.earth's carbon storage methodologies, which all require net-negative carbon footprint, durability, environmental and social safeguards, and financial additionality. Biochar is monitored during the project operation by determining the C:H ratio as an indicator of the degree of carbonisation of the biochar and is correlated to 100-year permanence fractions with minimal reversal risks. Once in the soil, it cannot be extracted economically due to natural soil mixing processes. The verification and crediting period is five years with annual audits. Biochar, if done properly, has climate benefits and presents a carbon removal with multiple co-benefits and SDGs contribution.

Comments

Berta Moya (Carbonfuture) said that biochar (BCR) is the first durable removal that could be independently certified and verified. BCR is widely available and accounts for 90% of durable CDR in the VCM. There are five existing standards that are evolving. Key elements are sustainability, product quality and clear CDR guidelines. Not all end uses of biochar lead to carbon removal. A transparent CoC is needed. Digital tools can be important to enable data tracking, verification and audit, and digitisation is needed for faster scale up.

Hamed Sanei (Aarhus University) explained that storage of inorganic carbon into carbonates is mineralisation, but storage of organic carbon into inertinites is in fact carbonisation or maceralisation. Inertinites such as biochar are actually not biological. The hundred-year timeframe is often quoted, as it is relevant to the carbon turnover in the biological domain, but the carbon cycle for inertinites is on a million-year scale.

Discussion

Simon Manley (UNDO) enquired how an identified decay rate of 0.3% a year relate to the idea of permanence in soil.

David Chiaramonti (Type A expert) highlighted that it is a given that biochar is stable for over 100 years and the problem lies in communication. From a scientific point of view stability is settled (centurial timeframe), but there is no general acceptance of this fact and no clear shared understanding of the level of recalcitrance.

Samantha Tanzer (TU Delft) enquired how to account for the lack of monitorability in the face of uncertainty and temperature-related degradation in the field (accelerated by global warming). **Hamed Sanei (Aarhus University)** answered that in the field there are losses due to erosion. In controlled 8½ year incubation studies, it was impossible to degrade more than 10% of carbon. The lost fraction is the labile fraction that is not fully carbonised and is shown in the models. The stable fraction remains permanently stable. It's better to talk about closed system rather than open system. With first order kinetic reactions the rate needs to be changed and the times shortened. If biochar was degradable, it should be possible to manipulate the reaction conditions to deliver degradation within a year. **Marianne Tikkanen (Puro.earth)** added that they seek to make a limit for a credit that some form is recognised as permanent, based on available science. **Berta Moya (Carbonfuture)** continued that the certification should focus on the stable fraction of biochar.

Fabian Levihn (Stockholm Exergi) enquired about the liability in case of unexpected degradation, as the shown 6% loss has a significant potential cost as removals. **Berta Moya (Carbonfuture)** explained that the 6% is not a blanket value, but always modelled with the Woolf correlation curve, which is deducted ex ante.

Juha Turkki (Climate Leadership Coalition) wondered if Puro has any recommendations on how to handle uncertainty in measurements. **Marianne Tikkanen (Puro.earth)** responded that the uncertainties in lab results are not great and are standard results. The 100-year extrapolation of the degradation curve shows greater uncertainty.

Eadbhard Pernot (Clean Air Task Force) pointed out that projects are done in the field instead of the lab and enquired how to shape the transition to field conditions with less monitoring opportunity. **Marianne Tikkanen (Puro.earth)** responded that the degradation

curve is based on field studies as well as closed system analysis. **Hamed Sanei (Aarhus University)** added that the aim of biochar CDR is to account for permanent carbon storage. The stage at which carbon becomes maceral as inertinite has a well-defined threshold and thus identified as stable fraction. Even if the material is lost from the site the carbon remains stored. **John Emerson (Copa Cogeca)** asked what the co-benefits of biochar are and how these are accounted for in the methodologies. **Marianne Tikkanen (Puro.earth)** answered that in Puro co-benefits are recognised (the project can mention and list them), but not quantified and do not influence the removal score.

A question from the **SLIDO** platform enquired if there is a soil pollution risk from biochar and how this can be safeguarded. **Berta Moya (Carbonfuture)** explained that there are quality requirements for certification (e.g. heavy metal content), which minimises the pollution risk. **Marianne Tikkanen (Puro.earth)** added that the Puro standard requires annual testing for heavy metals and poly-aromatics. Local authorities often also impose standards and local regulations are followed.

A question from the **SLIDO** platform enquired if biochar can be used in concrete and if it would be permanent in that application. **Berta Moya (Carbonfuture)** explained that there is a lot of promising research being done on material properties of biochar in concrete. Once biochar is in concrete, it cannot be removed. Concrete recycling does not involve thermal treatment, so the reversal risk is minimal.

A question from the **SLIDO** platform enquired if there should be a difference in the sustainability of BECCS versus biochar. **Marianne Tikkanen (Puro.earth)** pointed out that the merit order of different biomass uses should be a local issue. Biochar also creates bioenergy, it's multifaceted.

Eli Mitchell Larson (Carbon Gap) wondered if Puro's methodology is applicable to other use cases such as deep biomass burial or incorporation in polymers, and if the Commission envisions that applications resembling a closed system (e.g. concrete) fall into the products category instead of carbon farming. **Marianne Tikkanen (Puro.earth)** answered that they are open to other applications and the current methodology allows that. The degradation curve is not different, the soil-based curve is used even though it is clear that concrete conditions do not favour degradation. **Berta Moya (Carbonfuture)** explained that biochar is already produced and used in many projects, although the market for biochar is not yet present in all countries. This has led to cases where there were no customers in the farming sector and the biochar got sold for combustion use, which is another reason for tracking.

Kristin Jordal (Zero Emissions Platform) pointed out that biochar can also replace fossil carbon in smelting in for instance selenium, iron and steel plants, although the current use is limited. Here, CO_2 could be captured and stored geologically. **Marianne Tikkanen (Puro.earth)** explained that fossil coke replacement is seen as a reduction, not removal. There is no intention to credit carbon remaining in the steel itself.

Louis Uzor (Climeworks) wondered what should be considered permanent, as this can be seen as a political choice for the Kyoto process, and have clarity for the time period a methodology should consider uncertainty. **Hamed Sanei (Aarhus University)** explained that the 100-year time period originates from publications that project degradability and is a state-of-the-art approach. The degradable (labile) fractions in biochar are few. A linear projection is not an accurate characterisation, but there are tests and certifiability for biochar inertness. H:C ratio is

one of more options. **Marianne Tikkanen (Puro.earth)** added that the 100-year question can be seen more broadly and is indeed political, as is already made in setting GWPs.

David Chiaramonti (Type A expert) informed that the discussion on 100-year time period is referenced by scientific data. JRC carried out a meta-analysis of over 2000 texts and confirmed that the decay rate after the volatile part is gone is 0.0018% per year. Biochar application can be monitored and can be part of a sustainable farming system.

Jean-François Soussana (INRAE) pointed out that the specificities of biochar mean that it cannot be applied as other carbon farming activities. Farmers and rural communities need an integrated deployment of biochar, turning local biomass into local biochar use. In addition, several papers show (with high variability) N_2O reductions after biochar application and should be explored. **Marianne Tikkanen (Puro.earth)** responded that N_2O reductions are difficult to assess and left for later updates of the Puro standard.

Robert Höglund (Type A expert) pointed out that most published literature assumes total decay of biochar and that he has not seen peer reviewed papers demonstrating a labile and permanent fraction. He wondered when there will be scientific consensus on this permanence. **Hamed Sanei (Aarhus University)** answered that they will soon publish a 60-page publication on commercial biochar.

Harald Bier (EBI) clarified that the scientific evidence of permanent biochar exists but with different terminology. Lab trials are conducted to model behaviour in the environment. When a defined form of carbon is put into the carbon cycle, it will behave as modelled, even if it cannot be found due to erosion. There is more knowledge on the topic than is thought.

A question from the **SLIDO** platform enquired if climatic conditions in the field may affect the degradation of biochar. **Marianne Tikkanen (Puro.earth)** acknowledged that temperature varies in Europe and that the temperature curve gives a clue on the corresponding degradation.

Juha Turkki (Climate Leadership Coalition) commented that all CDR options are needed. Biochar seems a fast way and should become operational more quickly.

Chris Sherwood (Negative Emissions Platform) wondered if the use of biochar in plastics would have it exposed to higher temperatures (at end-of-life) and thus have a higher re-emission risk. **Marianne Tikkanen (Puro.earth)** clarified that the end use does not change the fact that biochar is a storage. There is no need for a separate modularity, it is enough to have rules for the end use. In Europe, incineration is a typical end-of-life for plastics, but in US they have very little waste incineration, so the re-emissions likelihood is regional. Biochar has many merits in fast-tracking carbon removal, shifting carbon from short to long cycle.

Berta Moya (Carbonfuture) concluded by stressing the high technology readiness level of biochar in Europe (8-9). When biochar is applied in an open system, the permanent part remains stable. This should be a focal point in the methodologies as well as how to account for carbon in a stable matrix, biochar in other products and the reduction of reversals in these products. Biochar should be considered separate from carbon farming.

Mineralisation – permanent storage in concrete
Chair: Laura Sales Pereira (ICF)

Presentation: a mineralisation methodology

Joana Vieira Duarte (Neustark) presented the Neustark carbonisation methodology, which injects CO_2 from a biogas plant into concrete granules from demolition waste, triggering a mineralisation process that transforms the CO_2 into mineral for permanent storage. The granules can be used to produce recycled concrete or roads. The project is certified by the Gold Standard. To ensure permanence, use cases that compromise the stability of the carbonate minerals are not allowed. The CO_2 value chain consists of liquefaction, transport and carbonation plant and does not consider pre-treatment unless additional steps are added. The baseline is assessed using the CDM baselining tool and CO_2 injection and output are accurately measured. The removal efficiency is 80 to 94%.

Comments

Wijnand Stoefs (Carbon Market Watch) recognised that the project has clear climate benefits, but said it's uncertain if it can be considered a removal. The permanence is not questionable, but in his view the system boundaries should include the cement industry. Cement is a storage medium and cement production emissions should be included to define this as an emission reduction versus removal. If waste is seen as a new resource that can be problematic. Truncating the system boundaries is 'risky'. **Joana Vieira Duarte (Neustark)** clarified that the baseline scenario allows to identify the project changes at existing recycling facilities. It is required to know what is additional in terms of what the project does. There is potential to reduce concrete use by use of carbonated aggregate, but the project does not account for this as it is preferred to be in the CDR market than the reductions market. **Wijnand Stoefs (Carbon Market Watch)** continued to ask how much the project replaces natural recarbonisation. **Joana Vieira Duarte (Neustark)** explained that the increase of the area to mass ratio does encourage increased natural carbonation, but the reactor process increases CO_2 absorption, and applies even after some natural carbonation has occurred. Natural carbonation would normally stagnate, additional carbonation can be delivered by concentrated CO_2 application. **Wijnand Stoefs (Carbon Market Watch)** asked for further elaboration on the leakage during the process. **Joana Vieira Duarte (Neustark)** responded that there is some risk of leakage through CO_2 absorption in pore space, which can later be emitted. With any new project, they do laboratory testing of material before the project starts. **Wijnand Stoefs (Carbon Market Watch)** wondered about the potential for perverse incentives by valorising concrete rubble. ECOS has published a paper 'no shortcuts for carbon removal in products'. Labelling of a product of this sort should reflect how they are used and how accounting is done.

Xavier Guillot (Holcim France and FastCarb) explained that the main difference between Neustark and the FastCarb approach is that FastCarb can use industrial flue gas without treatment. With a flue gas temperature 70-90 degrees, the carbonation is enhanced, which is tested with two pilots at cement plants. Quantification is based on direct assessment of stored CO_2. Environmental product declaration is enhanced by labelling as a negative emission aggregate that can reduce reportable footprint of product using it. Regarding sustainability, it is possible to use recycled aggregate in concrete. Properties can be improved by plugging pores and reducing absorption. The recommendation is to set up a comprehensive legal framework to support the implementation of such processes and investment in equipment. The relationship with ETS must be considered as well as the potential to reduce allowance requirements.

Discussion

Fabio Poretti (CEWEP) asked if Neustark has experimented with calcium-rich ashes recovered from waste incineration, and, if the CO_2 stream is pure, how much is adsorbed and

how much vented. **Joana Vieira Duarte (Neustark)** confirmed that they experimented and are now in the R&D phase. The process absorbs 10 kg per tonne of material in concrete, wherein ashes have a better uptake potential. **Wijnand Stoefs (Carbon Market Watch)** wondered about the additionality as this is apparently already being done.

Samy Porteron (ECOS) commented that decarbonisation of the construction sector does not rely on carbon removals. The current building stock should be taken into account and buildings should not be demolished before their time. The nature of incentives needs to be carefully considered. **Joana Vieira Duarte (Neustark)** responded that carbon removal should be seen as the last resort for non-avoidable emissions. CDR in concrete is a possible approach for this.

Wijnand Stoefs (Carbon Market Watch) wondered if there are more efficient alternatives for storage and if the natural recarbonation process is discounted. **Joana Vieira Duarte (Neustark)** responded that the granules are mainly used for the production of new concrete and that land filling practically never happens. Regarding natural carbonisation, after reaction the materials stay outside where natural carbonation takes place for weeks. The carbonates remain inert and are later used in conditions without the inflow of air which makes more carbonation unlikely.

Laura Sales Pereira (ICF) commented that the scoping paper analysis identified a method for concrete products 'CarbonPure' in which the project can claim removals as well as reductions. There, the CO_2 is sourced from industry or DAC, whereas Neustark restricts capture from DAC or biogenic sources.

Xavier Guillot (Holcim France and FastCarb) explained that smaller granule fragments have a higher potential and are used as powder for cement. He responded to the comment from ECOS that the life span of buildings may be prolonged to an extent, if the building is well constructed, but e.g. France alone has potential 20 million tons of concrete to be recycled that could be carbonated.

Veronica Egart (Swiss Environment Office) explained that Switzerland has a domestic crediting scheme and mineralisation is eligible. They consider the use of biogenic CO_2 as a removal, not a reduction. The scheme credits the net effect, so no leakage, and needs to reflect an actual removal or reduction. Additionality is thoroughly checked and projects require regulatory and financial additionality.

Louis Uzor (Climeworks) commented that, while the Neustark methodology is open to CO_2 sourced from DAC, which opens the door to the modular approached discussed the previous day, he believes it is not yet at a stage where Climeworks could use it.

Samantha Tanzer (TU Delft) commented that it makes sense to include the production of concrete in the value chain, but wondered where the boundaries of time should be set. **Samy Porteron (ECOS)** agreed that although the process is CO_2 injection, it is relevant how much CO_2 is stored and how much was emitted when the source material was made. In that sense, there is no net removal and only a fraction is stored. **Wijnand Stoefs (Carbon Market Watch)** stated that, in his view, time boundaries for removal activities should not be scientific but moral. Depending on when the climate crisis became an issue, this may be 50 to 100 years back. It is physically impossible to store more carbon than initially present, so how can this be a removal. **Robert Höglund (Type A expert)** disagreed with this view on how the project boundaries should be set in a comment.

A question from **Webex** enquired about the risk of reversal. **Joana Vieira Duarte (Neustark)** responded that the risk is negligible because the requirements demand that materials should not be exposed to certain conditions that would compromise them.

A question from the **SLIDO** platform enquired if the 30% of secondary raw materials as required by the EU Taxonomy would be a big sink if carbonated.

A question from the **SLIDO** platform enquired about the variance in the feed PSD and if the impact on the rate of carbon mineralisation is measured. **Xavier Guillot (Holcim France and FastCarb)** explained that they measure the total CO_2 that is stored, but not the relationship of the fractions. Literature may have an answer for this.

Fabio Poretti (CEWEP) commented that incineration bottom ash experiences natural carbonation, which may be accelerated with IR application. Literature shows enhanced CO_2 capture from bottom ash.

Fabian Levihn (Stockholm Exergi) asked if the transport of the material is included in the methodology. **Joana Vieira Duarte (Neustark)** responded that this would take place even in the absence of the carbon removal activity and, therefore, falls outside of the project boundaries.

Mark Preston Aragonès (Bellona Europe) asked if the additional fuel for transport, resulting from the additional weight from mineralised CO_2 added to the demolition waste, was included in the LCA.

Ron Schoenmakers (Netherlands) asked if perverse incentives are created for the demolition and replacement of buildings. Future emissions should also be taken into account to form the full picture and correct pricing, which may make it complex.

Oscar Rueda (CCS+ Initiative) reminded that regarding the overall impact of activities it is important to keep in mind that the methodology cannot solve all issues. What matters are environmental integrity and crediting. Also, it is important to include foregone emissions. Effects like perverse incentives can be considered, but we should avoid trying to make methodologies too comprehensive to avoid slow crediting.

Joana Vieira Duarte (Neustark) commented that perverse incentives for increased demolition are not likely due to the high cost of demolition and transport. In addition, currently all concrete recycling projects are microscale. It is important to build a quality standard with clear distinction for removals and reductions.

Xavier Guillot (Holcim France and FastCarb) concluded that this type of project is only viable if the recycling and storage operations are close to each other with short transportation requirements. In the FastCarb case, the CO_2 impact of transport and treatment must be deducted from the end product. There is huge potential for carbonation of demolition materials, regardless of the fact that this may not significantly reduce the carbon footprint of concrete.

Adrian Nicolae (DG CLIMA) made a general comment to think about the regulatory aspects in and beyond 2035, in the context of a declining ETS cap, namely how to take into account the

obligation of the CCS installations to reduce their fossil parts. Thereby feeding into the issue of additionality and the element of the capture and removal of biogenic feedstock.

Biogenic carbon storage in buildings
Chair: Sevim Aktas (DG CLIMA)

Presentation: survey results on methodologies for long-lasting biogenic carbon storage in buildings
Jannes Nelissen (CRETA) presented an overview of certification methodologies for long-term biogenic carbon storage in buildings gathered from the survey and literature. Among the 30 identified methodologies, 30% were dynamic Life Cycle Assessments (LCA), 60% were established and market-tested, and 47% were geared towards project-level certification. Regarding quantification, generally a static LCA approach is used to quantify the amount of stored carbon. Dynamic methodologies are more accurate but may be less transparent due to complexity. Consideration of both financial and regulatory additionality is standard practice. For long-term storage, monitoring is required in only 50% of cases, and liability clauses are seldom included. For timber, certification of sustainable sourcing is commonly used as an eligibility requirement to ensure a neutral impact on biodiversity. Incentives to promote recycling and reuse have been incorporated by two methodologies. The analysis leaves room for discussion and questions, which are included in the report. CRETA encouraged the EG to provide feedback via the Basecamp platform.

Florie Gonsolin (CEFIC) asked via Webex why the presentation of Jannes only included wooden products. **Sevim Aktas (DG CLIMA)** clarified that when referring to long-term biogenic carbon storage in buildings, it encompasses all bio-based products, not exclusively limited to wooden products.

Comments
Bunthan Iea (French Ministries of Ecology, Energy and Territory (France)) explained that in France, environmental regulations for new constructions require building owners to calculate and report the global warming impact of the construction and building use phase. Label Bas Carbon (LBC) measures the net benefit of biogenic materials in buildings, encompassing Global Warming Potential (GWP) and various biobased materials, not limited to wood alone.

Sacha Brons (Climate Cleanup Foundation (CCF)) clarified that their startup is developing a methodology for biogenic storage of carbon, which includes both wood and other products. Their focus of the assessment of carbon storage has shifted from product level to building level.

Frank Vasek (Timber Finance) elaborated that their organisation is developing a carbon removal methodology specifically tailored for timber used in buildings, shifting from their previous perspective on assessing the forest to the construction phase of the timber's lifecycle.

Panel
Question 1: What scope do you prefer: building (project) level or product level?

Sacha Brons (CCF) answered that there are established standards for assessing the environmental performance at both levels: EN15978 for buildings and EN15804 for product level. The rationale for focussing the carbon removal certification on product level lies in the abundance of available data, such as Environmental Product Declarations (EPD), which enables better incentive structures and optimisation of production/materials. On the other hand, an

argument for building level is the ability to monitor the entire lifespan of a building, determining its existence or demolition.

Frank Vasek (Timber Finance) responded by explaining that their approach involves examining the building level from the demand side, considering carbon pools in relation to this perspective and exploring ways to increase these pools. In this context, monitoring and assessing permanency can be conducted at building level.

Bunthan Iea (France) agreed with the arguments regarding monitoring and permanency. In France, Label Bas Carbon (LBC) mandates the building owner to calculate the carbon stock, simplifying the certification process by providing straightforward basis for the calculations.

Kelsey Perlman (FERN) stated that the potential expansion of wood production without causing significant environmental degradation and loss of forested coverage is problematic. Europe consumes 96% its own wood production, with a 70% increase between 2000 and 2019 due to the demand in wood fuel and products. Both the beginning and end of the LCA needs to be considered and afforestation and reforestation need to be taken into account. A complete picture of the overall carbon sinks within Europe is required to set effective incentives to prevent rebound effects.

Question 2: Is a static or dynamic LCA preferred?

Sacha Brons (CCF) answered that the choice between static and dynamic LCA depends on the available experience and data for each approach. Currently they use static LCA in accordance with EU norms and plan to advance their approach as they gather more knowledge on improvements. The concept behind dynamic LCA is based on the notion that in 50 years, the weight of the carbon impact is lower than if it were released today.

Frank Vasek (Timber Finance) responded that they use static LCA, but they consider a permanence of approximately 80 years, assuming that 80% of carbon is accounted for during this period. Their current procedure is already complex, and more data is needed before considering a shift to dynamic LCA. **Sacha Brons (CCF)** added that they use a similar approach regarding permanence, assuming that only 50% can be justified.

Bunthan Iea (France) explained that LBC also uses static LCA, but as more information becomes available, they may shift to dynamic LCA.

Question 3: What is your experience with data availability?

Sacha Brons (CCF) shared that while the administration is inevitable, leveraging existing information from EDP databases and EU-wide certification and regulations should help mitigate the burden.

Frank Vasek (Timber Finance) explained that Timber Finance is looking towards a global application, which can be data intensive due to the diversity of planning regulations and standards worldwide. Specifically focussing on timber production, their goal is to aquire more specific and tailored data at regional level, enabling them to identify the source location of timber instead of relying on the currently used default values.

Bunthan Iea (France) shared that in France, numerous existing regulations facilitiate the compilations of data related to building materials. The Enviro (RE2020) regulation, enabled the expansion of data availability for carbon assessments from about 200 products to between 4000-5000 EPDs available to be utilised. To encourage the utilisation of longer-lasting products, providing incentives like impact discounts for products that increase the life span of the building can help.

Kelsey Perlman (FERN) stressed the significance of data availability for improved certification. An EU traceability law could help to improve the knowledge gaps regarding biomass sourcing. Currently, it is estimated that an average of 12% is of unknown origin according to the JRC. There are existing examples demonstrating how to trace the source of the wood. This kind of data is key to also track the impacts on biodiversity and forest health.

Question 4: How was the baseline for the building level designed?

Sacha Brons (CCF) explained that this relates to sustainability, especially for timber. Baselines need to be country-specific, including the substitution effect (based on baseline assumed). On the building level, the baseline is almost always zero.

Frank Vasek (Timber Finance) informed that they use two different baselines – storage in construction and sequestration in the forest. The decay functions are currently limited and need to be improved to be country-specific. There is also the question about how to incentivise the use of wood as a resource for construction.

Bunthan Iea (France) stated in France they started with a generic baseline derived from an estimation of the volume and market share of the different products, using various scenarios. They hope to improve the baseline calculation by including better data in the future.

Kelsey Perlman (FERN) enquired Bunthan how the methods are addressing the cumulative effect of wood over time and how it shifts across different sectors. **Bunthan Iea (France)** responded that the idea is to incorporate as much biobased material as possible in the future and improve the baseline. **Kelsey Perlman (FERN)** continued that the ability to examine overall material use is more important than just focussing on sustainability. Without adequate baselines, it becomes challenging to demonstrate any process in the direction cascading utilisation.

Sacha Brons (CCF) added that the IPCC standard currently accounts for half-life of wooden products and extrapolates it to the end of life cycle that is reported by the project operator. For instance, in a scenario with a committed time span of 100 years, the baseline for timber-based products would be 30.5% of carbon storage. However, this approach might reflect a fair scenario, as the project generates additional carbon removal by shifting the carbon from short-life cycle sectors to the long lasting products. This shift should be reflected in the baseline calculation for the entire harvested wood products pool to ensure a fair evaluation of the carbn storage impact.

Frank Vasek (Timber Finance) added that when looking from the perspective of forest, climate change has the potential to destroy the economic value of the forest. This, in turn, may have implications on the certification of wooden products.

Question 5: From the building perspective, what measures should be included and what does that mean for incentives and co-benefits?

Sacha Brons (CCF) responded that their method is based on two Dutch reports by the STS and ASN bank, which incentivise reuse, circularity, and cascaded use. To increase the life span of buildings from 75 to 100 years, the reusability of the materials would help. This approach not only promotes circularity but also provides net carbon removal benefits.

Frank Vasek (Timber Finance) explained that Timber Finance takes an approach involving the modelling of reference buildings and additionally works on building a reference database of circular building methods. It is important to accumulate this knowledge and data regarding which elements can be reused in the construction process.

Bunthan Iea (France) pointed out LBC has introduced a point system that rewards co-benefits such as biodiversity and improved social impacts.

Kelsey Perlman (FERN) warned that sustainability as a co-benefit must be linked to impacts on biodiversity. Ideally, ancient forests should not be sourced, but it's very difficult to identify the location and management practices of these forests, as the EU does not currently map primary and old-growth forests. A potential concern is also that wood that has been harvested illegally could also be certified. This poses a challenge that needs to be addressed to ensure proper safeguards.

Sacha Brons (CCF) agreed with Kelsey Perlman and suggested to also include environmental co-benefits such as avoiding the use of chemicals. This challenge must go beyond forests within the EU.

Frank Vasek (Timber Finance) commented they are cautious about the source and duration of forest sourcing, typically opting for sustainably managed practices.

Bunthan Iea (France) added that the origin of the resources is important. However, to avoid complications in the process, he cautioned against including too many criteria if these are not necessarily useful.

Discussion

Fabian Levihn (Stockholm Exergi) inquired about how the methods account for the rebuilding or reconstruction of parts of the building during its lifetime. **Frank Vasek (Timber Finance**) explained that their approach involves solely long-lasting construction elements (structure elements), ensuring that the lifespan of the biobased products as aligns with the entire building'slifespan. The biobased material is replaced with when the entire building undergoes replacement. **Sacha Brons (CCF)** added that the replacement of elements may influence the building's overall lifespan. Third party monitoring could facilitate adjustments to the carbon storage of materials if they are replaced, and a buffer pool could account for any premature losses. Upon completion, the credits may be rewarded with a clause for reversal after the project. **Bunthan Iea (France)** agreed with the monitoring of short-lasting material structures but noted that due to complexity, it is preferable to use the protocol for carbon stock to calculate the entire building as one unit.

Samantha Tanzer (TU Delft) inquired about the timing in the life cycle when credits should be issues and when the carbon is assumed to be stored. **Frank Vasek (Timber Finance)** responded that there is no clear answer to this question, as more building materials will be reused and cascaded, extending the life cycle. Timber is more expensive for construction and if crediting over time is complex then it's difficult to set the incentive for the use of timber. **Sacha Brons (CCF)** added that upon completion, the credits may be rewarded with a clause for reversal after the project, a point agreed upon by **Bunthan Iea (France).**

Samy Porteron (ECOS) shared his approval for efforts redirecting wood usage away from bioenergy to storage. He inquired about the lifespan for inclusion in an accreditation system. The discussion of static versus dynamic LCA does not matter in the context of certification, as it doesn't add a substantial solution in storing carbon regarding longevity. He also asked if LBC is used for purposes beyond carbon emissions offsetting, such as procurement. **Bunthan Iea (France)** responded that currently LBC is not used for other purposes, although for instance a charcoal electricity plant could potentially purchase it to comply with regulations.

Kelsey Perlman (FERN) pointed out that if monitoring (parts of) a building proves to be difficult, there are high risks (to safeguarding permanence and credit value) and that alternative methods might be more effective.

Aric Gliesche (Switzerland) commented via Webex that data quality is an issue and shared their approach to account for Harvested Wood Products (HWP) over 9-10 years in Switzerland. Their focus is on the sawmills, considering them as critical points for HWP production, allowing plausibility assessments at every level. From their experience the best practice is to measure at the beginning of the value chain. Regarding permanence, they use the IPCC approach with inflow and outflow calculations and half-life of products. He enquired insights on handling costs when monitoring on building level. **Sacha Brons (CCF)** responded that they use cadastral and satellite data for monitoring. Regarding cost-effectiveness, liability can be transferred when a company ceases operation. For instance, it could go to the certification scheme or another organisation that can use open data for monitoring. **Frank Vasek (Timber Finance)** added that they also use remote sensing for monitoring. By focusing on the structural elements at building level, the costs can be reduced. **Bunthan Iea (France)** expressed uncertainty about the costs of monitoring at building level, as they only calculate the gain and benefits at the start of the project. Remote sensing for monitoring is not yet done in LBC.

Giulia Stellari (Type A expert) wondered about what happens to the credits if the building company goes bankrupt. **Frank Vasek (Timber Finance)** responded that buildings are considered investment properties, and buyers typically have emission targets they need to meet by reducing or offsetting emissions. They can use their own portfolio of buildings for this purpose. However, determining liability in the event of bankruptcy is challenging. It remains difficult to decide whether the liability should stay with the initial developer or the investor. Additionally, liability cannot be demanded from residents that own a biobased construction home.

Chris Sherwood (Negative Emissions Platform) questioned whether he understood correctly that if a building is destroyed after 50% of its lifecycle, 50% of the credits remain intact. In his view, this should not be possible as it would be no longer removed but re-emitted.

Francesco Mirizzi (European Industrial Hemp Association) enquired how many methodologies contained elements for fiber crops, as it needs specific considerations. **Jannes**

Nelissen (CRETA) answered that the survey included one methodology specifically for hemp, one methodology for the calculation for hemp and flax, and three were certification methodologies for all kinds of biobased materials. Nelissen explained that the focus on wood-based methodologies is more prominent in the discussion since it is further developed and is about long-term storage.

Sacha Brons (CCF) concluded the discussion by stating that there are currently drafting a methodology on construction, which served as input in the EG survey. This methodology includes five pilot projects on building level and will continue to project level. The report will be available March 2024.

Improving MRV of emerging methodologies: enhanced weathering
Chair: Andrea Klaric (DG CLIMA)

Panel

Question 1: How do you define project boundaries of an enhanced weathering project and which direct and indirect emissions do you account for?

Freya Chay (Carbon Plan) explained that weathering is a natural process wherein chemical reactions between rock, water and air remove CO_2 from the atmosphere. This process can be sped up by crushing rock to increase the surface area and putting it in reactive places such as agricultural soils or beaches. There are several phases to account for, namely rock application, the environmental weathering phase, rock dissolving processes in the field and soil and leaching. The boundary stretches from the rock sourcing to rock application and some monitoring. She emphasised that there is no correct way to do measurement and modelling, due to the complexity of data sources and quality.

Question 2: Could you present the main aspects of UNDO's methodology for enhanced weathering?

Simon Manley (UNDO) answered that they had to develop the methodology from scratch, using the best practice guidelines on GHG accounting and science. It is currently being independently validated to conform with ISO standard. This experience led to working with the Verra expert group and the methodology is now the cornerstone of Isometric's version, with more methodologies to come which would hopefully be part of the CRCF project.

Question 3: Could you tell us about the level of uncertainty in predicting CO_2 uptake from enhanced weathering over a specific period of time?

Sophie Gill (Isometric) explained that it's possible to model a weathering curve, but to verify and validate the results it's important to take measurements, which also improves the quality of the model. In addition, they quantify the uncertainty by conducting simulations, which can be used to for ex-post credits. The registries should be transparent about the data and decisions made to justify the rates of removal crediting.

Question 4: How burdensome is the sampling requirement to validate results and costs?

Sophie Gill (Isometric) responded that it's scientifically rigorous to validate models with measurement. Field measurements allow observation of removals in field. As validation goes

forward there may be opportunities to increase reliance on the modelling aspect as more data is collected.

Simon Manley (UNDO) added that they are currently in a phase that is measurement heavy, there is a need to generate field data for verification. Within 3 to 5 years they can shift to a model heavy measurement as the quality of field data improves.

Freya Chay (Carbon Plan) shared that models are currently too unreliable and it is unrealistic to ask projects to validate system level modelling assumptions on e.g. river/ocean dynamics. System level efforts are needed to validate those models.

Question 5: After application of mineral particles in an agricultural, these tend to leach out. How are measurements done in that case?

Sophie Gill (Isometric) pointed out that the ultimate reservoir is the ocean, which may take a decade to reach from the field. In-field measurements can demonstrate the alkalinity loss in the top soil.

Question 6 (SLIDO): There is an absence of modelling or sampling that can verify that it is actually CO_2 that is absorbed or another chemical. Can you clarify?

Freya Chay (Carbon Plan) elaborated that when rocks dissolve they release cations, but this may or may not cause carbon formation. The cations absorb acid that may or may not be carbonic. It's important to consider non-carbonic weathering.

Simon Manley (UNDO) confirmed that currently there is no consensus on measuring techniques. Using a single measurement technique might not give you the full picture.

Question 6: What are the reversal risks after storage and is this well understood?

Sophie Gill (Isometric) answered that at a broad scale, reversal risk is about processes such as outgassing and cation exchange that can happen on the path from the field to the river. These loss processes are well understood. With a largescale application of enhanced weathering it will actually become easier to identify a signal in the river from multiple projects.

Freya Chay (Carbon Plan) added that there is some potential for non-linearity in reversal phenomena that need to be considered. There is some potential for unknown unknowns to be aware of. Claims are made for short timescales, but long timescales should be kept in mind.

Question 7: What sustainability risks and co-benefits exist and how well are these understood?

Simon Manley (UNDO) explained that the public methodology of Puro calls for full environmental risk assessment audited by an expert organisation. The main risk is heavy metal depositing, that can be avoided by understanding the mineralogy of the rock being used. There are co-benefits in terms of improving soil health. The rock will tend to leave various lighter metals in the soil that have a fertilisation role. These benefits are acknowledged by existing methodologies as nature-based solutions.

Sophie Gill (Isometric) confirmed that the composition of the mineral rock is important to avoid contaminants and will include this in the protocol. Co-benefits are important to focus on as well.

Discussion

Matthew Clarkson (InPlanet) commented that the idea of reversal and liability does not apply as the definition considers final storage in the ocean. The processes Freya identified are 'downstream losses', a credit accounts for those losses and therefore there is no reversal. Like biochar, you can bring losses ex ante. Rock powders have been used in organic agriculture so there is data to ensure safety of application. Monitoring soil health can be part of the MRV.

Eli Mitchell Larson (Carbon Gap) wondered if investors allow to publish the measurement data that was acquired through these initial projects. **Simon Manley (UNDO)** responded that they understand that there is the need to share data and support it at the executive and investor level. However, there are elements of the data systems that are proprietary. Data will be published 'to the extent it can improve methodologies'. **Matthew Clarkson (InPlanet)** shared his experience that people can still be rather vague on IP and a bit protective. InPlanet sees value in sharing and prioritises research.

Samantha Tanzer (TU Delft) commented that when net removals are ex-post credited there are upfront emissions followed by gradual removals and enquired how these upfront emissions happen and need to be repaid. **Simon Manley (UNDO**) replied that the underlying processes have a carbon cost, which are measured and amortised across the crediting period. Taking them up front is not viable as there are no removals at first.

Chris Sherwood (Negative Emissions Platform) enquired how the baseline is set and additionality is identified as some of these mineral powders are already used in agriculture. **Simon Manley (UNDO**) replied that regarding this is a relatively standard process in Brazil, but not so much elsewhere in the world. **Matthew Clarkson (InPlanet)** explained that from an academic standpoint, it is developed in Brazil but still only covers about 5% of farmers. Additionality comes from having a proven technology (chemical fertilisers) but rock powder is costly and can be funded by the carbon credit. ERW also tends to use rock powder in much larger quantities than in a fertilisation approach. Some fertiliser rock powders are not actually great CDR rocks. **Sophie Gill (Isometric)** added that if fields have previously been applied with rock powder, that should be considered in the baseline.

Mark Preston Aragonès (Bellona Europe) commented that the removal happens through a complex interaction with a broader system and wondered how to attribute the removal to a given rock and how accurate the removal calculation is. **Freya Chay (Carbon Plan)** answered that regarding physical chemistry processes it is possible to be confident of having delivered an improvement. Pinning down exact removal is more difficult. There may be a role for uncertainty discounting. **Mark Preston Aragonès (Bellona Europe)** asked if it is possible to be really confident of delivering net benefit given upfront emissions. **Sophie Gill (Isometric)** confirmed that it is possible and measurement-based ex post verification is important. Regarding additionality there is a good understanding of carbon chemistry. It is a matter of measurement and accounting, wherein uncertainty quantification is important. **Freya Chay (Carbon Plan)** added that throwing rock powder does not automatically absorb carbon to that extent and it is good to keep tabs on that. **Matthew Clarkson (InPlanet)** commented that the upfront emission is in the order of 5-7% of the CDR potential. An advantage of ERW is that it uses understood

technologies. **Simon Manley (UNDO**) shared that their upfront emissions are 3-5%. **Sophie Gill (Isometric)** repeated to get the quantification scientifically correct to give confidence in protocols.

Simon Manley (UNDO) concluded that this methodology has the potential to remove millions of tons of CO_2 from the atmosphere. It is an open system which requires measurement. He implored to incorporate enhanced weathering into the methodology development.

Sophie Gill (Isometric) emphasised the need to set high quality quantification framework for MRV and share the data and register as part of the MRV process. Enhanced weathering has the potential for upscaling, but needs to be done responsibly with correct quantification.

Freya Chay (Carbon Plan) agreed that enhanced weathering has a high potential for carbon removal. MRV standards should be oriented towards learning about where and when weathering is effective and co-benefits are delivered.

5. Next steps

Christian Holzleitner (DG CLIMA) concluded that the Commission is open to the advice of the Expert Group on the prioritisation for the development of methodologies. The first poll had high votes for carbon farming. Another poll may be held to discover which methodologies are most mature and suitable for upscale. This will likely be done after the scoping paper framework is in place.

The main focus in the coming months will be to conclude the framework with parliament and Council, for it to be stable to continue. In the meantime, the EG is invited to share their feedback on the scoping papers via Basecamp until the deadline of 10 November 2023. The scoping papers will be published in January, after which the key findings will be summarised.

Christian Holzleitner (DG CLIMA) warmly thanked all the participants for their active participation and contributions and welcomed any further input and suggestions for the next meeting.

6. Next meeting

The next meeting of the EG will combine carbon farming, industrial removals (permanent storage and long-lasting carbon storage products), and verification and registries rules. It will take place in a hybrid format in April 2024. The precise date of the meeting will be announced in due time.

Annex 1: List of participants

List of representatives of members of EG participating, including Observers, ad hoc invited participants, and European Commission

A-Type Members of Expert Group (independent experts)	
Last name	**First name**
CAMES	Martin
CHIARAMONTI	David
MILCINSKI	Grega
OLESEN	Asger
PERUGINI	Lucia
RÜTER	Sebastian
STELLARI	Giulia Marina
VAN ACKER	Joris
HOGLUND	Robert (Observer)
JOOSTEN	Hans (Observer)
TAMME	Eve (Observer)

B-Type Members of Expert Group		
Last name	**First name**	**Organisation**
GRANHOLM	Kaj	Baltic Sea Action Group
KRACKE	Frauke	Stripe climate / Frontier
VOYSEY	Andrew	Climate Agriculture Alliance (Observer)

Representatives of C-Type Members of Expert Group
Bellona Europa
Carbon Market Watch
CEFIC (European Chemical Industry Council)
CEMBUREAU - The European Cement Association
CEWEP, Confederation of European Waste-to-Energy Plants
Clean Air Task Force
Climate Leadership Coalition
Confederation of European Forest Owners (CEPF)
Confederation of European Paper Industries (CEPI)
Copa Cogeca
Ecologic Institute
Environmental Coalition on Standards (ECOS)
European Biochar Industry (EBI)
European Confederation of Woodworking Industries (CEI-Bois)
European Council of Young Farmers (CEJA)
European Environmental Bureau
European Landowners' Organization
European State Forest Association (EUSTAFOR)
FoodDrinkEurope
I4CE Institute for Climate Economics (Observer)
IETA (International Emissions Trading Association)

IFOAM Organics Europe
Indigo Agriculture Europe GmbH (Observer)
IOGP International Association of Oil&Gas Producers
ISCC System GmbH (Observer)
Negative Emissions Platform
Negative Emissions Platform
REC Standard Foundation (Observer)
Stichting BirdLife Europe
Stockholm Exergi AB
TIC Council
Umweltbundesamt GmbH (Observer)
Zero Emissions Platform (ZEP)

Representative of D/E-Type Members of EG	
Delegation	**Organisation**
Austria	Federal Ministry for Climate Action, Environment, Energy, Mobility, Innovation and Technology
Belgium	Environment Public Service/Climate Change Unit
Bulgaria	Ministry of Environment and Water
Croatia	Ministry of economy and sustainable development
Cyprus	Department of Environment
Cyprus	Department of Environment, Climate Change division
Czechia	Ministry of the Environment
Denmark	Danish Ministry of Climate, Energy and Utilities
Estonia	Ministry of the Environment of the Republic of Estonia
Finland	Ministry of Agriculture and Forestry of Finland
Finland	Ministry of Economic Affairs and Employment of Finland
Finland	Ministry of the Environment
France	Ministry of Agriculture
France	Ministry of Energy transition
Germany	BMEL
Germany	BMUV
Greece	Ministry for Environment and Energy
Hungary	Institute of Agricultural Economics
Hungary	Ministry of Agriculture of Hungary
Hungary	Ministry of Agriculture of Hungary
Ireland	Department for Agriculture, Food and Marine
Ireland	Department of the Environment, Climate and Communications
Italy	Institute for Environmental Protection and Research, ISPRA
Italy	Ministry of the Environment and Energy Security
Italy	Ministry of Agriculture, of Sovereignty
Italy	Food and Forestry
Latvia	Ministry of agriculture
Lithuania	Ministry of Environment
Lithuania	State Forest Service
Lithuania	The Ministry of Agriculture
Netherlands	Ministry of Agriculture, Nature and Food Quality

Norway	Norwegian Environment Agency
Poland	Ministry of Climate
Portugal	Portuguese Environment Agency
Romania	Ministry of Environment, Waters and Forests
Slovakia	Ministry of Agriculture and Rural Development
Slovakia	Ministry of Environment
Slovenia	Slovenian Forestry Institute
Spain	Ministry for the Ecological Transition
Sweden	Swedish Environmental Protection Agency

Invited experts: *representative from*
Microsoft
Aarhus University
Carbfix
Carbon Gap
Carbon Market Watch
Carbon Plan
Carbonfuture
CCS+ Initiative
Cerulogy (Scientific coordinator)
CEWEP
Clean Air Task Force
Climate Cleanup Foundation
Climeworks
Danish Energy Agency
Delft University
FastCarb
FERN
French ministry of Ecology, Energy and Territory
ICF (Project manager)
Isometric
NEGEM
Neustark
Partners for Innovation (CRETA-project manager)
Puro.Earth
Stockholm Exergi
Timber Finance
Umweltbundesamt GmbH
UNDO

European Commission: *representative from*
DG AGRI
DG CLIMA
DG ENER
DG ENV
DG GROW
DG RTD
JRC

Annex 2: Questions from the public ('Slido')

The questions below were raised on the 'Slido' platform and will be taken into account as input for the subsequent meetings of the EG.

Question text	**User Name**
Our solution decarbonises gas fields at source, producing hydrogen, with CCUS, no transportation. Can we join the 'transportation & geological storage' session?	Belinda Perriman
Is there a reason why stable Mineral-associated organic carbon is not considered?	Glyn Mitchell
How will the "guidelines" on methodologies by co-legislators affect the work of the expert group? Will the April meeting work to adapt to the new ideas?	Anonymous
Will the Technical scoping paper be shared outside the expert group?	Anonymous
Would you say the methodology process is more of a trial and error?	Anonymous
Can the panels comment on the requirement of quantified specifications for Key Performance Indicators in the methodologies, to substantiate CDR qualities?	Anonymous
For Climeworks. Most carbon projects add also to sustainable goals. DAC may have no negative impact on nature;is Climeworks not considering positive SDG impact?	Jos Cozijnsen
Would you say the methodology process is more of a trial and error?	Anonymous
Commodity industries have deep experiences with quantified specifications for KPI's for product quality. How can CDR methodologies include them for CDR quality?	Wilfried Maas
Biomass import from abroad is allowed in this methodology. How is this sustainable when scaled up? Are the transport emissions really negligible in the LCA?	Anonymous
If biobased CO2 is part of ETS and stored via ETS and CCS directive will the get extra EU Allowances? Or can he use removal credits for his ETS plant?	Jos Cozijnsen
Envi have stressed that Biochar Carbon Removal can be in permanent storage category. This would require geological storage, how is this practically possible?	Anonymous
Camera is on Fabien not on Marianne FYI	Anonymous
The latest research is showing biochar as permanent carbon removal. The puro.earth methodology is not including this research, but the CRC-F should.	David
Should biochar be taken out of the carbon farming category since it is an industrial, technical solution and stable for hundreds to thousands of years?	Morten Heick
If carbon removal is stored in soils on farms should the carbon removal credit then not be given to the farmer?	Sanne Dekker FrieslandCampina/EDA
Biochar is obviously permanent and should be in the permanent category in the CRC-F	Anonymous
There has been some discussion about the risk of soil pollution from biochar? Can you explain if and when that could be an issue and how it can be safeguarded?	Sanne Dekker FrieslandCampina/EDA
What about biochar in concrete? Permanence is ensured?	Anonymous
Following the European Biochar Certificate, biochar is safe and also beneficial for soils.	David
I would like to ask the question about where and how much of the biomass for the production of biomass should comes from in the future?	Aaron Scheid
When science is convinced about the permanence of biochar disregarding where it is stored why does the CRCF-proposal insist on geological storage?	Peter Lindholst, Stiesdal SkyClean
What happens to the ecosystem services (water retention, biodiversity, etc) when biochar is added to soil? Are there any studies that look into this in detail?	Aaron Scheid

Views of the presenters on the potential human health impacts of biochar application (toxicity, PM10, etc.)? https://doi.org/10.1016/j.scitotenv.2019.05.007	Anonymous
A “geological storage” criteria will incentivize biochar producers to put biochar in geo-storage, and society would miss out on the agricultural co-benefits.	David
Biochar should be taken out of the carbon farming category since it is an industrial, technical solution and stable for hundreds to thousands of years	Anonymous
CRCF should provide clarity on permanence: equilibration carbon pool with air vs. material robustness of the carbon carrier vs. monitoring duration vs. claims	Anonymous
Biochar is a carbon farming activity leading to increase soil C stock and it can be combined with sustainable soil management practices, minimum tillage..	Francesca
Biochar has tremendous potential for cement applications that will also constitute as permanent carbon removal and help decarbonise the cement industry.	Anonymous
The co-benefits of biochar can be applied to the carbon farming category to help grow the biochar market / storage potential & benefiting farmers with subsidies	Anonymous
Co-benefits of biochar in soils also include emissions reductions with nitrous-oxide and carbon dioxide from fertilisers	Anonymous
Camera was left on Robert - can we move it back to the room/standard slide?	Anonymous
Permanent storage: Biochar Carbon Removal (BCR), Carbon farming: Biochar co-benefits / Carbon in products: Biochar in concrete.	Anonymous
What is the variance in your feed PSD, do you measure the impact this has on the rate of carbon mineralisation?	W.Savage
Eu taxonomy requires 30% secondary raw materials (inventive to demolish?) If those 30% are carbonated this would be a big sink	Anonymous
Should the project boundary be expanded to also include the emissions from the production of cement (for both carboncure and neustark) examples? And if so, how?	Anonymous
On the previous question, an additional point: how to measure the Carbon content of old concrete structure ?	Anonymous
European standard series on sustainable countruction works (i.e. EN15804) should be mandatory requirement with respect to quantification of storage/aditionality	Sebastian Rüter
The biggest wood products producers (SWE;FIN) see their carbon sink decrease. How to ensure that we are not incentivising a sink reduction for a temp. solution?	Anonymous
There is an inconsistency between national estimates (production approach) and simple LCA which does not differentiate between origin of wood (incl also import)	Sebastian Rüter
"Dynamic LCA" is not in line with EN 15804 and ISO 21930...	Sebastian Rüter
Is stimulating cutting trees to use in products for 10 to 60 years after which they are down cycled or incinerated really a sustainable storage policy?	Anonymous
How about the inconsistency between national HWP estimates (production approach) and applicaton of LCA data (not (yet?) discriminating in origin of wood)?	Sebastian Rüter
Sacha, where the wood used in construction in the Netherlands is coming from? What % coming locally? Are transport emissions included?	Anonymous
"Baseline" on national scale would be the current market situation regards the use of different building materials.	Sebastian Rüter
How to deal with the difference between claimed lifespan and actual lifespan? Monitoring for the lifespan:does the entity that receives the credits still exist?	Anonymous
For Sam, only 18,7% of the felled material in Europe ends up in long term purposes, not 45%	Anonymous

As regards biogenic "fibre crops" other than wood (HWP), there is no commonly agreed methodology (IPCC) to estimate emissions/removals ("sink" & net removal)	Sebastian Rüter
How can ERW methodology account for the total CO2 drawdown vs only dissolved rock, as the CO2 needs to be absorbed by the rock, not any other acid or chemical?	Anonymous
I have not yet seen modelling or sampling that can verify that it's actually CO2 that has been absorbed by the rock vs. another chemical. Can you clarify?	Anonymous