Support to the development of methodologies for the certification of industrial carbon removals with permanent storage

Technical Assessment Paper on certification methodologies of permanent carbon removals

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In association with:

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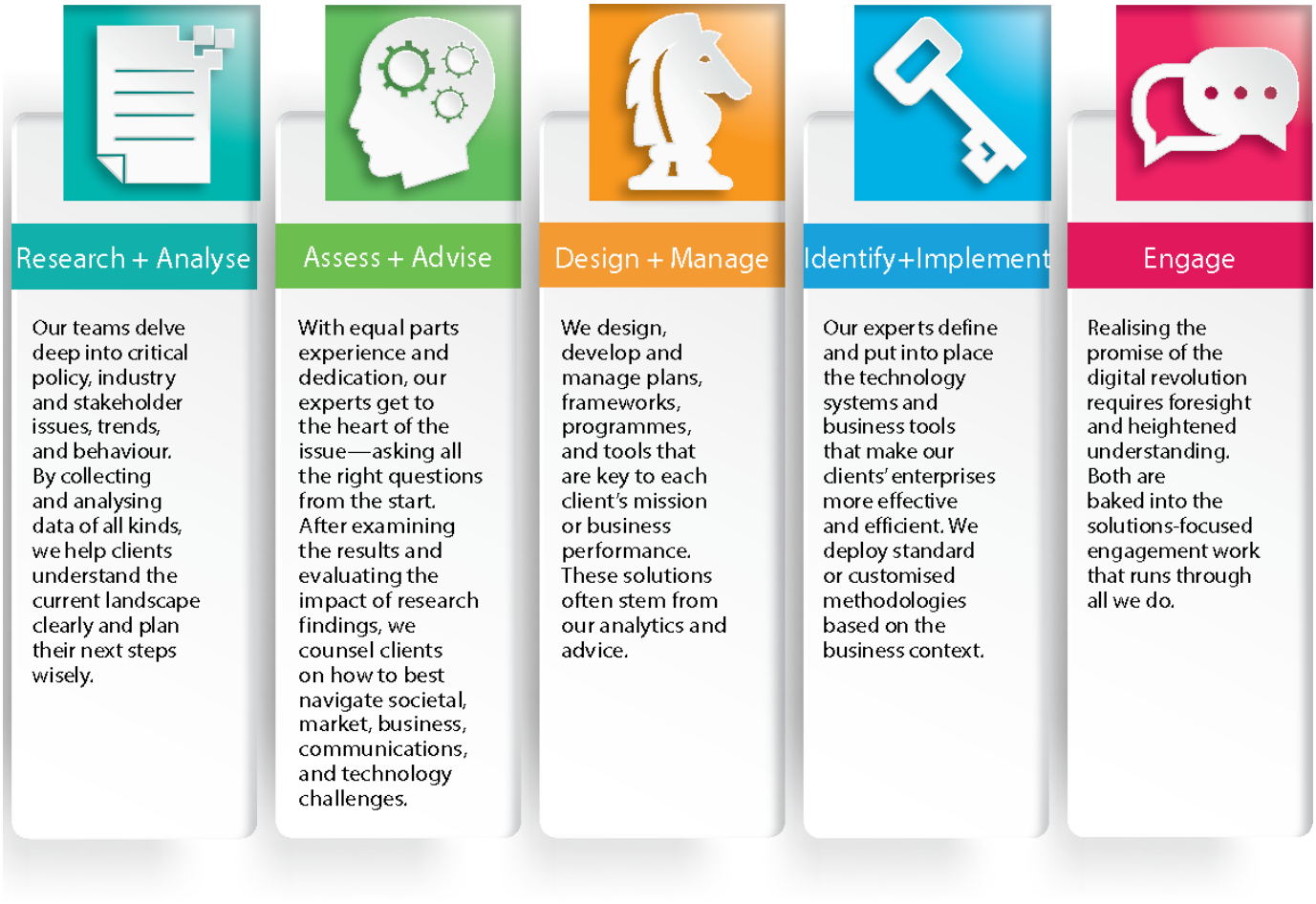

Support to the development of methodologies for the certification of industrial carbon removals with permanent storage

Technical Assessment Paper on certification methodologies of permanent carbon removals

A report submitted by ICF S.A., Cerulogy and Fraunhofer ISI

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Summary

On 20 February 2024, EU institutions reached a provisional agreement on the establishment of the first EU-level certification framework for permanent carbon removals, carbon farming and carbon storage in products, abbreviated in this document as the CRCF, which stands for 'carbon removal certification framework'. This Regulation is intended to facilitate and encourage the deployment of permanent carbon removals, carbon farming and carbon storage in products through the adoption of certification methodologies for specific carbon removal activities. Privately and publicly operated certification schemes will be approved by the Commission to certify carbon removal projects against these certification methodologies.

In the context of this Regulation, this paper considers important principles to be considered in the development of certification methodologies for permanent carbon removals in the EU, and presents possible approaches for the implementation of the QU.A.L.ITY (quantification, additionality, long-term storage, and sustainability) principles laid out in the provisionally agreed Regulation. The following table summarises the preliminary findings based on the longer discussion detailed in section 2 of this document.

Summary of key issues and preferred approaches

Area	Issue	Preliminary finding
Quantification	How should the breakdown of emissions in the $GHG_{associated}$ term be implemented in reporting?	We are inclined to maximise the information available to the carbon removals market by asking for emissions to be broken down by source with an indication given of which emissions are ETS regulated and whether they are Scope 1, 2 or 3.
	Should $GHG_{associated}$ include emissions from capital goods (i.e. facility and equipment manufacture and construction)?	■ We believe that the likely materiality of capital emissions should be considered on an activity by activity basis in the formulation of certification methodologies. ■ For activities where it is believed that capital emissions could be significant, the certification methodology should require capital emissions accounting with materiality screening. ■ In order to ensure consistency with the principle of treating non-biomass based renewable energy as zero emissions, capital emissions from renewable energy facilities should be excluded. ■ If included, we suggest that capital emissions should be amortised over 20 years and then set to zero if the project is re-certified beyond that point.
	How should emission factors be allocated to electricity consumed by a carbon removals project?	We propose to apply in the certification methodologies the rules from the RFNBO framework for treating consumed electricity as zero emissions.

Area	Issue	Preliminary finding
	How should indirect (market mediated) emissions be considered?	■ The proposed treatment for electricity emissions, which would include consideration of displacement emissions, is detailed in the previous section 2.1.4. ■ For other indirect emissions expected to be material, we suggest that where viable the certification methodologies should set eligibility criteria with a view to avoiding those emissions, so that they may be treated as zero. This should be assessed on an activity-specific basis for each methodology. ■ In some cases, it may not be considered appropriate/possible to avoid indirect emissions. In those cases, quantification approaches should be considered on a case by case basis. ■ In the case of displacement of displacement effects due to competing demand for [non-electrical] energy or waste heat, we propose to follow the example of the rigid inputs rules from the Innovation Fund. ■ In the case of ILUC, it could be considered to follow the approach of the RED II. The RED II gives estimated ILUC values for, respectively: cereals and other starch rich crops; sugars; and oil crops. All other sources of biomass are considered in the RED II to have zero associated ILUC emissions. This would be expected to apply to most biomass feedstock for carbon removal projects
	What approach or approaches should be used for assessing and reporting uncertainty in net carbon removals?	■ We suggest that uncertainty could be appropriately handled by requiring key uncertainties to be identified and quantified to the extent possible and by requiring narrative confirmation that net removals are unlikely to have been overestimated. ■ Where activities are subject to key uncertainties that are expected to be common across projects, these should be identified in the relevant certification methodologies.
	How many times should projects be permitted to renew the activity period?	The provisionally agreed CRCF text does not require a limit on activity periods, and the project team sees no compelling reason to impose one.

Area	Issue	Preliminary finding
	How should standardised baselines used to establish project additionality be set?	■ We suggest setting a standardised baseline of zero for projects where carbon removal units represent the only revenue stream or are clearly the primary revenue stream. ■ Standardised baselines for other activities should be assessed on a case by case basis with reference to potential revenues.
Additionality	What requirements should be set on financial additionality testing?	The CDM investment analysis tool is seen as an appropriate basis for financial additionality testing rules under the CRCF.
Long-term storage	The CRCF requires long-term storage of certified removed carbon, but does not state a specific minimum timeframe on which this must be assessed	We suggest that minimum expected storage periods should be set in the certification methodologies on an activity specific basis. Where an activity is associated with an expected storage period in another piece of legislation (e.g. the specifications for geological storage under the CCS Directive) then that period should be reflected in the certification methodology.
	Should it be acceptable to issue net carbon removal units based on modelling approaches?	We believe that it is appropriate to rely on elements of modelling in issuing carbon removal units, but that this needs to be established on a case by case basis in the certification methodologies
	Different types of carbon removal activity may physically deliver net carbon removals either before or after the point of implementation of the certified activity, and these cases could be treated differently his may affect certificate issuance	At this time, we suggest that the principle of issuing carbon removal units only after the net carbon removal has been physically achieved should be adopted, with the exception of biomass-based removals for which carbon removal credits would be issued following demonstration that carbon has entered permanent storage
	What reversal risk assessment should be undertaken for project certification?	We suggest that certification methodologies should identify reversal risks that project operators should assess for a given activity.
Sustainability	How can the scheme recognise co-benefits given that it would not be permissible to issue 'bonus' carbon removal units in recognition of sustainability performance?	We suggest that the activity-specific certification methodologies should identify areas where there is potential to deliver a co-benefit that would be a substantial contribution to a given sustainability area, and provide criteria to allow this contribution to be assessed.

In addition to the issues included in the above table, and as a next step, we will need to consider a number of other issues in the process of developing the first certification methodologies under the CRCF. These include in particular: setting project boundaries; assessing biomass sustainability; setting liability mechanisms; and implementing the requirement from Recital 18a that “to avoid unsustainable demand of biomass raw material, the financial benefits related to the certification should not lead to an increase of the capacity of a bioenergy plant beyond what is necessary for the operation of the carbon capture and storage”.

1 Introduction

On 20 February 2024, EU institutions reached a provisional agreement on the establishment of the first EU-level certification framework for permanent carbon removals, carbon farming and carbon storage in products[1], abbreviated in this document as the CRCF, which stands for 'carbon removal certification framework'. This Regulation is intended to facilitate and encourage the deployment of permanent carbon removals, carbon farming and carbon storage in products through the adoption of certification methodologies for specific carbon removal activities. Privately and publicly operated certification schemes will be approved by the Commission to certify carbon removal projects against these certification methodologies.

The Regulation states that certification methodologies should be developed in close consultation with the Expert Group on Carbon Removals ("the Expert Group") and with other interested actors. This paper, which has been shared with the Expert Group in advance of its fifth meeting, in April 2024, is intended as a basis for discussion of a number of issues that must be considered in the process of drafting the first set of certification methodologies.

The provisionally agreed text emphasises the importance of consistency with existing legislation, and the Commission intends that, where appropriate, the certification methodologies will align with measures from other regulations and directives, in order to limit regulatory inconsistencies and complexity.

1.1 Purpose and structure of this paper

A previous review paper for this project titled 'Support to the development of methodologies for the certification of industrial carbon removals with permanent storage: Review of certification methodologies and relevant EU legislation'[2] (henceforth "the review paper") discussed a number of existing frameworks for carbon reduction and carbon removal certification, including identifying a number of key areas of difference between those frameworks – areas in which approaches may need to be decided for EU certification methodologies. This technical assessment paper is informed by that review paper and the feedback received on it from the Expert Group.

The paper is divided into two chapters following this introduction:

- Chapter 2 presents options for dealing with a range of issues, including identifying the approaches that are provisionally considered the most appropriate by the project team and European Commission.
- Chapter 3 discusses how a modular approach may be taken to the development of the certification methodologies and provides an indication of what the priorities are for this workstream through the rest of 2024.

The views of the Expert Group on the issues raised in a draft of this paper were solicited through a structured survey made available through the EUSurvey portal

[1] https://www.consilium.europa.eu/en/press/press-releases/2024/02/20/climate-action-council-and-parliament-agree-to-establish-an-eu-carbon-removals-certification-framework/

[2] https://climate.ec.europa.eu/document/download/28698b02-7624-4709-9aec-379b26273bc0_en?filename=policy_carbon_expert_carbon_removals_with_permanent_storage_en.pdf

and through discussion at the Expert Group meeting held in April 2024. Following receipt of this feedback a number of clarifications have been made to the paper, and the feedback is informing the ongoing work of developing draft certification methodologies.

1.2 Authors of the paper

This paper was developed by a team comprising ICF, Cerulogy and Fraunhofer ISI for the Directorate General for Climate Action (DG CLIMA). The ideas expressed in this paper reflect the views of the authors and are intended as an input to the ongoing engagement between DG CLIMA, the Expert Group and the rest of the community. Unless explicitly identified as such, nothing in this paper should be understood to represent a position of the European Commission, nor as a statement of any institutional position on behalf of any of the consortium members.

1.3 Note on legislative references

The legislative references to the CRCF in this paper are based on the version of the CRCF provisionally agreed by the trilogue and sent to the permanent representatives committee[3]. There may be differences in pagination, numbering and/or text between this version and the final published Regulation when it becomes available.

[3] https://data.consilium.europa.eu/doc/document/ST-7514-2024-INIT/en/pdf

2 General issues for the EU carbon removal certification methodologies

This chapter returns to several of the points identified in the review paper, and other certification issues identified as important, and identifies options for dealing with these issues in the EU certification methodologies. As previously noted, feedback on these decisions will be solicited from the Expert Group.

The issues identified in this chapter are potentially relevant across a range of carbon removals technologies. We have split this chapter into sections which discuss the following types of issue:

- Quantification and boundaries;
- Additionality and baselining;
- Long-term storage;
- Sustainability.

In each section, a brief discussion of the issue is provided, followed by a summary table detailing the pros and cons of each option for handling that issue in the EU certification methodologies.

2.1 Quantification and boundaries

2.1.1 Reporting emissions from carbon removal activities

2.1.1.1 Lifecycle emissions accounting

The provisionally agreed CRCF text requires that the calculation of permanent net carbon removals should be based on the equation:

$$Permanent\ net\ carbon\ removal\ benefit = CR_{baseline} - CR_{total} - GHG_{associated}$$

In this equation, the term $GHG_{associated}$ is defined as "the increase in direct and indirect greenhouse gas emissions, over the entire lifecycle of the activity which are due to its implementation, including indirect land use change, calculated, where applicable, in accordance with protocols set forth in the 2006 IPCC Guidelines for National Greenhouse Gas Inventories and any further refinement".

The use of a lifecycle analysis[4] (LCA) approach allows the net benefits from the introduction of a carbon removal activity to be identified. The European Environment Agency defines LCA as:

"A process of evaluating the effects that a product has on the environment over the entire period of its life thereby increasing resource-use efficiency and decreasing liabilities. It can be used to study the environmental impact of either a product or the function the product is designed to perform. LCA is commonly referred to as a 'cradle-to-grave' analysis. LCA's key elements are: (1) identify and quantify the environmental loads involved; e.g. the energy and raw materials consumed, the emissions and wastes generated; (2) evaluate the potential environmental impacts

[4] Also known as lifecycle assessment.

of these loads; and (3) assess the options available for reducing these environmental impacts."[5]

The term 'indirect greenhouse gas emissions' is used to refer to market-mediated emissions occurring outside the control of the project operator and other producers in the supply chain, with the agreed CRCF text giving the examples of indirect land use change emissions and displacement effects due to competing demand for energy or waste heat.

All the existing certification approaches considered for the review paper that net reductions/removals should be assessed using some form of LCA approach. The scope adopted for an LCA calculation can vary based on the rules set in a given context. For example, some LCA frameworks may treat capital emissions (see section 2.1.2) or indirect emissions (see section 2.1.4) as out of scope.

Some feedback received on the review paper suggested that the scope for carbon removal emission accounting should be restricted to the consideration of emissions sources directly under the control of the project operator. It was argued that as other emission sources in the lifecycle of a carbon removal activity could be regulated under the EU ETS, imposing an LCA requirement could lead to a form of double counting of emissions, as ETS allowances would be cancelled for some emissions also counted in the assessment of net carbon removals. Adopting a narrow scope for emissions accounting in the CRCF would, however, create the risk that activities could be certified that would not deliver any net carbon removal if assessed on a full lifecycle basis.

An example would be a DACCS facility using electricity from a relatively high carbon-intensity grid. The emissions from electricity production for the air capture process could be enough to entirely offset the benefit of the carbon storage (see e.g. Deutz & Bardow, 2021), but without some form of lifecycle accounting the DAC facility would have carbon removal units issued for the full volume of CO_2 captured. While it could be argued that the electricity generation emissions were already offset by the cancellation of EU ETS allowances and that this could be seen as protecting the environmental integrity of the associated net carbon removals, this would be unlikely to be seen as satisfactory by purchasers of net carbon removal units. The Microsoft 'Criteria for High Quality Carbon Dioxide Removal'[6], for example, require that, "Project-level carbon accounting reports all greenhouse gas emissions associated with a CDR project using repeatable and verifiable GHG quantification methods. In general, this requires the use of cradle-to-grave life cycle assessments (LCAs)."

2.1.1.2 Disaggregated emissions reporting

The provisionally agreed CRCF text requires that carbon removal certificates must include information to identify not only the net carbon removal delivered, but also to identify the "breakdown by gases, sources, carbon sinks and stocks with regard to" emissions identified under the $GHG_{associated}$ term as well as the $CR_{baseline}$ and CR_{total} terms. The requirement to breakdown emissions by gases and sources therefore applies to the lifecycle emissions calculation undertaken to calculate the $GHG_{associated}$ term. It may not be proportionate to explicitly identify every emission

[5] https://www.eea.europa.eu/help/glossary/eea-glossary/life-cycle-assessment

[6] https://query.prod.cms.rt.microsoft.com/cms/api/am/binary/RWGG6f

source included within the LCA, but sources could be grouped for the sake of reporting into lifecycle stages (for example 'inputs', 'transport', 'electricity', 'fuel combustion').

Disaggregated reporting of the terms of the LCA for $GHG_{associated}$ will increase the transparency of the system, and also provides a basis for a more flexible use of the LCA data. For example, there may be carbon removals applications in which it would be considered important or useful to distinguish between ETS-regulated and non-ETS-regulated emissions in the $GHG_{associated}$ term. Disaggregating sources and identifying them as either non-ETS-regulated or as ETS-regulated would enable such applications. Similarly, it may be considered useful in some contexts to distinguish between the 3 emission scopes of the GHG Protocol for corporate accounting. If requiring reporting by ETS status then for some terms in the lifecycle calculation it would be necessary to provide guidance as to which the appropriate categorisation would be, as it would not be proportionate to expect a carbon removal operator to directly confirm ETS regulation with every supplier of a minor input.

Reporting the breakdown of $GHG_{associated}$		
Issue	Certificates should include a breakdown of emissions in the $GHG_{associated}$ term	
Relevant text in the CRCF	Annex II (m) of the CRCF requires certificates to include "breakdown by gases, sources, carbon sinks and stocks with regard to the information referred to in points (j), (k) and (l) ".[$CR_{baseline}$, CR_{total} and $GHG_{associated}$]	
Relevant approaches in existing methodologies	Existing methodologies require that disaggregated GHG information is provided to verifiers, but we are not aware of methodologies in which that is included in public reporting	
Options	**Pros**	**Cons**
Disaggregate $GHG_{associated}$ term by individual sources	■ Maximise transparency ■ Maximise information available to the market for carbon removal units	■ Larger administrative burden ■ Likely to disclose information considered business sensitive ■ Harder to ensure consistency in reporting
Disaggregate $GHG_{associated}$ term by source categories (e.g. inputs, transport, …)	■ Transparency in the $GHG_{associated}$ term ■ Most consistent with existing schemes ■ Allow net removals to be recalculated to an alternative scope	■ Does not provide information to the market on the emissions' ETS status/GHG Protocol reporting scope

Disaggregate $GHG_{associated}$ term by source categories and require indication of GHG Protocol corporate reporting scopes (Scope 1, Scope 2, Scope 3)	■ Provide an indication of what part of $GHG_{associated}$ is associated with processes under the control of the operator, what part should reduce as the electricity grid decarbonises, what part may be reduced by third party action	■ Requires additional record keeping compared to approach without identification of emission scopes ■ It is currently unclear to us how much value Scope reporting would provide to the carbon removals market ■ Potential to disclose information considered business sensitive
Disaggregate $GHG_{associated}$ term by source categories and require indication of ETS status (ETS-regulated, non-ETS-regulated)	■ Provide information about which parts of the lifecycle contribute to the $GHG_{associated}$ term ■ Allow net removals to be recalculated to an alternative scope (for example to exclude capital emissions, see section 2.1.2)	■ Requires additional record keeping compared to approach without identification of ETS-status of emissions ■ Potential to disclose information considered business sensitive
Disaggregate $GHG_{associated}$ term by source categories require indication of both GHG Protocol scopes and ETS status	See above	See above
Suggested approach		
Preliminary findings	We are inclined to maximise the information available to the carbon removals market by asking for emissions to be broken down by source with an indication given of which emissions are ETS regulated and whether they are Scope 1, 2 or 3.	
Open questions	How much value will be delivered to the market by reporting emissions information	
Next steps	Feedback from Expert Group	

2.1.2 Should emissions associated with 'capital goods' be considered under an LCA approach?

The provisionally agreed CRCF text refers in the definition of $GHG_{associated}$ to emissions from the "entire lifecycle" but does not explicitly address capital emissions (defined as emissions associated with manufacturing equipment and constructing facilities, referred to as "One-time effects" in the GHG Protocol project reporting standard). Recital 8 states that the term $GHG_{associated}$ should include "any associated GHG emissions occurring during the lifecycle of the activity and related to the implementation of the activity", but does not include capital emissions in the list of examples of emissions that should be included, "Relevant GHG emissions that should be taken into consideration include direct emissions, such as those resulting from the use of fertilisers, chemicals, fuel or energy, other material inputs and

transportation, or indirect emissions, such as those resulting from land use change with consequent risks for food security due to displacement of agricultural production, or displacement effects due to competing demand for energy or waste heat". It is therefore not explicit from the provisionally agreed text whether (or in what circumstances) capital emissions must be included in the LCA calculation for the $GHG_{associated}$ term.

In many existing LCA schemes, such as the rules used for fuels under the Renewable Energy Directive II (RED II) or the emissions avoidance calculation under the Innovation Fund, capital emissions are treated as out of scope. The reasons for treating such emissions as out of scope may include:

1. An (informed) assumption that across the lifetime of a process the capital emissions are low compared to other emission terms in the calculation, and thus that excluding them does not materially affect the conclusions of an analysis;
2. Consistency, where capital emissions for other processes have previously been excluded on the grounds of non-materiality in the same LCA framework or in related LCA frameworks;
3. The burden of asking facility operators to calculate emissions from capital goods; and,
4. That in a decarbonising economy the emissions associated with capital goods production can be expected to reduce and therefore become less material over time.

In the case of carbon removals, several existing standards ask operators to include capital emissions in the assessment of net removals delivered. Based on the standards assessed for the review paper, the inclusion of capital emissions appears to be normative for standards developed with a focus on carbon removals (the voluntary standards that exclude capital emissions are ACR and Gold Standard, both developed with a focus on achieving emissions reduction rather than removal certification). The use of the word 'any' by Recital 8 in specifying "any associated GHG emissions occurring during the lifecycle of the activity and related to the implementation of the activity" and the word 'entire' by Article 4(1)(c) in specifying that $GHG_{associated}$ is "the increase in direct and indirect greenhouse gas emissions, over the entire lifecycle of the activity" might be taken to suggest that the scope for emissions assessment ought to be drawn broadly, and therefore should include capital emissions where they are considered material. We note that the JRC's International Reference Lifecycle Data System (ILCD) Handbook[7] states that, "Misleading results may occur when system boundaries are drawn in a way that important processes are excluded e.g. due to … systematic exclusion of … the production of capital goods."

Consideration of capital emissions need not necessarily imply a full accounting of capital emissions for all projects. Across the gamut of carbon removals projects, there is the potential for capital emissions to be material in some cases, and immaterial in others. Disregarding capital emissions could therefore lead to uneven comparison of different types of projects. This concern is reflected by the inclusion of capital emissions in current voluntary standards. Some form of materiality

[7] https://eplca.jrc.ec.europa.eu/uploads/ILCD-Handbook-General-guide-for-LCA-DETAILED-GUIDANCE-12March2010-ISBN-fin-v1.0-EN.pdf

screening could be included as part of the certification methodologies, allowing projects where the capital emissions can reasonably be assumed to be below a certain threshold to undertake only a preliminary assessment rather than full accounting. For some carbon removal activities, it may be reasonable to exclude capital emissions from the activity-specific certification methodology entirely.

Accounting for capital emissions introduces a question of amortisation – over what period should the capital emissions be spread? Amortising over a short period increases the capital emission term relative to the annual removals delivered. Amortising over a longer period reduces the capital emission term relative to annual removals delivered. For example, the RED sets an amortisation period of 20 years for the accounting of land use change emissions.

For projects that will operate on a long-term basis and that would be permitted to recertify, there is also a question about whether and when capital emissions could be considered to be 'spent'. For example, if capital emissions were amortised over 20 years, should they then be set to zero for the second period of operation of a facility? This approach is suggested by the Climeworks methodology, for instance. An approach in which capital emissions are considered spent after a certain period might be seen as characterising the environmental advantages of continuing to use existing equipment rather than building new facilities, but it might also be seen as advantaging existing facilities over new facilities. If newer technologies have advantages that cannot be captured in a CO_2e emissions assessment (for example, more efficient use of resources) it might be considered undesirable to systematically disadvantage them against older facilities through the net removals assessment.

Another question that is raised by accounting for construction emissions is whether it may be assumed that some or all of the materials used will be recycled at the end of the facilities' working life. In an LCA of the Climeworks DAC process, Deutz & Bardow (2021)[8] shows that construction emissions are reduced to less than half if credit is given for the recycling of materials (primarily steel and aluminium) that have embedded emissions. We note that the Deutz & Bardow (2021) study suggests that capital emissions are quite marginal for the DAC case considered. Even ignoring the savings from material recycling, the capital emissions contribution is assessed as 0.015 kg per kg CO_2 captured, i.e. 1.5% of the CO_2 benefit of capture is lost to capital emissions. This makes the capital emissions term relatively small compared to the potential emissions from energy consumption.

If requiring accounting of capital emissions, there is also a question about the scope to be considered. For example, for DAC using renewable energy the capital emissions associated with solar or wind power are potentially larger than the capital emissions associated with the DAC plant itself, but renewable energy from solar and wind is treated as having zero emissions in other EU policy such as the RED II. Capital emissions may also not be included in lifecycle inventory characterisations of the emission intensity of other inputs. If projects were required to account for capital emissions for on-sire renewable power but not for renewable power brought in from third party providers this would create an inconsistency in scope between projects and could lead to discrepancies in the calculation of net removals.

[8] https://www.nature.com/articles/s41560-020-00771-9

Capital emissions		
Issue	Should $GHG_{associated}$ include emissions from capital goods (i.e. facility and equipment manufacture and construction)	
Relevant text in the CRCF	The provisionally agreed text refers to the “entire lifecycle” but does not explicitly address capital emissions. They are not mentioned in Recital 8 which provides examples of emissions that should be included.	
Relevant approaches in existing methodologies	There are examples of private standards treating capital goods emissions as both in scope and out of scope	
Options - inclusion	**Pros**	**Cons**
Include capital emissions in $GHG_{associated}$ (without materiality screening)	■ Potentially significant emissions would be identified and accounted ■ No risk of materiality screening excluding a significant term	■ Assessment may be burdensome for some operators ■ Additional burden to operators to calculate capital emissions that may not be material
Include capital emissions in $GHG_{associated}$ (with materiality screening)	■ Potentially significant emissions would be identified and accounted ■ Materiality screening reduces operator burden	■ Assessment may be burdensome for some operators ■ Assessing capital emissions for on-site renewables but not could distort market
Include capital emissions in $GHG_{associated}$ (with materiality screening) with an exemption for renewable electricity generation facilities	■ Potentially significant emissions would be identified and accounted ■ Materiality screening reduces operator burden ■ Treatment of on-site renewable electricity generation capacity would not be made less favourable than treatment of electricity bought in from outside	■ Assessment may be burdensome for some operators ■ Would not capture emissions associated with installing renewable electricity generating equipment
Exclude capital emissions from $GHG_{associated}$	■ Minimise burden on operators	■ Would fail to account for emissions that could undermine environmental integrity of carbon removal certification
Options - amortisation	■ **Pros**	■ **Cons**
Set capital emissions to zero after 20-year amortisation period	■ The total capital emissions accounted over time would match the total calculated capital emissions	■ Could be seen to disadvantage new facilities over existing facilities
Account capital emissions at a constant	■ A more consistent treatment between new	■ For long-running projects, total emissions accounted

value even after 20-year amortisation period	facilities and existing facilities	over time could exceed total calculated capital emissions
Suggested approach		
Preliminary findings	■ We believe that the likely materiality of capital emissions should be considered on an activity by activity basis in the formulation of certification methodologies. ■ For activities where it is believed that capital emissions could be significant, the certification methodology should require capital emissions accounting with materiality screening. ■ In order to ensure consistency with the principle of treating non-biomass based renewable energy as zero emissions, capital emissions from renewable energy facilities should be excluded. ■ If included, we suggest that capital emissions should be amortised over 20 years and then set to zero if the project is re-certified beyond that point.	
Open questions	■ Which activities are likely to be associated with significant capital emissions?	
Next steps	■ Evidence on likely capital emissions must be reviewed for each activity for which a certification methodology is proposed.	

2.1.3 How should the GHG intensity of consumed electricity be assessed?

The provisionally agreed CRCF text states that the term $GHG_{associated}$ should include "direct emissions, such as those resulting from the use of … energy, … or indirect emissions, such as those resulting from … displacement effects due to competing demand for energy or waste heat." Some carbon removal projects, for example DAC projects, will involve a significant amount of electricity consumption. The treatment of the GHG intensity of that electricity could significantly impact the net carbon removals calculated for a project. Deutz & Bardow (2021) show that a DAC project using electricity at the average GHG intensity of the German grid could result in net emissions rather than removals[9]. Even if electricity is nominally identified as coming from a renewable source there is a risk that displacing that nominally renewable electricity from other users on the grid will lead to an increase in generation of fossil power – it is therefore important that additional consumption of renewable power should be associated with additional generation of renewable power.

The question of assigning GHG intensity to consumed electricity has recently been considered by the EU in the context of the lifecycle accounting for e-fuels[10] (as a subset of renewable fuels of non-biological origin) under the RED II. In particular, this involved a discussion of when it could be allowable to treat grid electricity consumed by a project as wholly low carbon (and in particular wholly renewable). There is an existing system of Guarantees of Origin (GoOs) for renewable electricity that is used to allow electricity to be sold to consumers as renewable without generated quantities being double counted, but the Commission concluded that this

[9] Specifically in the case of a lower-efficiency project generating its own heat.

[10] I.e. hydrogen from electrolysis and hydrogen-derived fuels, see https://ec.europa.eu/commission/presscorner/detail/en/qanda_23_595

system is not appropriate for the identification of consumption as low GHG intensity in a fuel LCA context[11]. This is because the purchase of GoOs has historically been a weak driver of the deployment of additional renewable power capacity – i.e. the act of purchasing a GoO is not expected to lead to the additional generation of an equivalent quantity of renewable power. It would therefore be expected that if e-fuel producers or other electricity consumers purchased GoOs to claim full renewability this would result in shuffling of non-renewable power to other customers.

Existing voluntary certification schemes for carbon removals considered in the review paper have not directly addressed this question of additional renewability, unless to state that emissions from displacement of low carbon electricity are out of scope, but they do set requirements on how electricity carbon intensity may be assessed. For example, the CCS+ DAC methodology allows a project to treat electricity from a directly connected renewable energy source as zero emissions 'if the sourced is off-grid and captive', while if grid connected electricity is consumed grid average emission factors must be used. Allowing renewable electricity to be treated as low GHG intensity only in the case of a direct off-grid connection may be unduly restrictive. The system as a whole can be run more efficiently if renewable capacity is connected to the grid and available to the system rather having a less coherent renewable energy system in which generators are each connected to a single user and excess power must be wasted.

Delegated Acts to the RED II[12] have therefore introduced mechanisms for the identification of consumed power as additional renewable electricity, which is assigned zero emissions. These rules cover both direct connections to renewable facilities and the purchase of renewable power over the grid. Under these rules, power nominally purchased from a renewable supplier, but which does not meet the set conditions, is not treated as renewable, and is therefore assessed at the average GHG intensity and renewability of the grid. Grid power can be identified as zero carbon under the following conditions:

1. The average proportion of renewable energy consumed in the local bidding zone was over 90% in the previous calendar year[13]; or,
2. The average greenhouse gas intensity of the electricity in the bidding zone is below 18 gCO_2e/MJ[14] and the fuel producers have power purchase agreements (PPAs) with renewable power generators and meet conditions on the geographical and temporal correlation of power consumption and generation; or,
3. Electricity is consumed during periods in which renewable power would otherwise be curtailed; or,
4. The operator has PPAs power purchase agreements with renewable power generators that came into operation no more than 36 months before the installation of the Renewable Fuels of Non-Biological Origin (RFNBO) facility, and the power generator has not received state support in the form of operating or investment aid; or,

[11] Cf. https://theicct.org/publication/what-does-it-mean-to-be-a-renewable-electron/

[12] https://ec.europa.eu/commission/presscorner/detail/en/qanda_23_595

[13] Once this condition is triggered the rules state that electricity in this bidding zone shall be treated as renewable for the subsequent 5 years even if the renewable fraction changes.

[14] An analogous same five-year rule applies.

5. The number of load hours during which the facility operates in a year is equal to or lower than the number of hours in the preceding calendar year for which reliable data are available during which the marginal price of electricity was set by installations producing renewable electricity or by nuclear power plants; or,
6. The marginal unit generating electricity at the time of operation is zero carbon, if this information is available from the national Transmission System Operator (TSO).

If none of these conditions is satisfied, then electricity may be assigned either the average GHG intensity of electricity for the country or (if information is available) the GHG intensity of the marginal unit generating electricity at the time the electricity is consumed.

Applying these rules for the net carbon removal certification methodology would allow projects to identify consumed electricity as zero carbon in cases where the projects are unlikely to lead to displacement emissions due to additional fossil power generation, and ensure that estimated displacement emissions are accounted in other case. For projects with low electricity consumption the option to report all consumed power at a national grid-average emission factor would still be available, avoiding the burden of demonstrating renewability for small amounts of electricity consumption.

GHG intensity of consumed electricity		
Issue	How should emission factors be allocated to electricity consumed by a carbon removals project	
Relevant text in the CRCF	Recital 8 states the term $GHG_{associated}$ should include indirect emissions from "displacement effects due to competing demand for energy or waste heat". Recital 4 states that carbon removal projects should, "result in an unambiguous net carbon removal benefit, while avoiding greenwashing."	
Relevant approaches in existing methodologies	Existing methodologies generally allow the use of national grid average electricity emission factors. Some allow electricity sourced by direct connection to a renewable electricity plant to be treated as zero carbon. Some refer to the CDM Tool to calculate the emission factor for an electricity system.	
Options	**Pros**	**Cons**
Apply the rules developed for assessing the GHG intensity of electricity in the context of RFNBOs	■ Provide a robust framework to demonstrate that the consumption of electricity in the name of climate change policy does not lead to significant net emissions from additional fossil power generation ■ These rules are already adopted under the RED II	■ These rules are somewhat complex

Treat only electricity sourced from a direct connection to a renewable power generating facility as zero carbon	■ This approach is simpler than the RFNBO rules ■ This approach would reward projects that support renewable power facilities	■ This approach does not provide any option to treat electricity as zero carbon when sourced over the grid or partly from nuclear generation ■ Less flexible that the RFNBO approach
Allow the cancellation of guarantees of origin as a basis to treat electricity as wholly renewable and zero carbon	■ This approach would be simple for operators ■ As sourcing GoOs is currently less costly than supporting additional renewable power generation this would reduce operator costs	■ A GoO based framework would not robustly avoid displacement emissions
Suggested approach		
Preliminary findings	■ We propose to apply in the certification methodologies the rules from the RFNBO framework for treating consumed electricity as zero emissions.	

2.1.4 How should indirect emissions be considered?

As discussed in the review paper, some carbon removal projects may cause indirectly GHG emissions because of 'market mediated' effects. In the GHG Protocol guidelines for project accounting these are referred to as "Upstream and downstream emissions involving market responses"[15]. It should be noted that this usage of the idea of indirect emissions is distinct from the usage in the GHG Protocol Corporate accounting guidelines[16], where the term 'indirect' is used to refer to any emissions that are not under the direct ownership or control of a company and includes all emissions under 'Scope 2' (from electricity generation) and 'Scope 3' (all other emissions). The CRCF Recital 8 states that indirect emissions should be considered and specifically mentions indirect land use change (ILUC) and displacement effects due to competing demand for energy or waste heat as examples of indirect emissions in the definition of $GHG_{associated}$. Indirect land use change refers to the case that increasing the use of agricultural land to supply a given project may lead to expansion of agricultural area at some other (unknown) location. Recital 8 of the provisionally agreed text also mentions "displacement effects due to competing demand for energy or waste heat".

A number of existing methodologies require project operators to consider at least some market-mediated indirect emissions. There is no single applicable framework that could readily be applied to the identification and estimation of all types of indirect emissions, and therefore individual certification methodologies may need to explicitly identify those indirect emissions that must be assessed. In the case of indirect land use change, the RED II Annex VIII Part A includes "provisional estimated ILUC emissions" for starchy, sugary and oily biofuel feedstock crops, and

[15] https://ghgprotocol.org/sites/default/files/standards/ghg_project_accounting.pdf

[16] https://ghgprotocol.org/sites/default/files/standards/ghg-protocol-revised.pdf

RED II Annex VIII Part B states that biofuels produced from other feedstocks "will be considered to have estimated indirect land-use change emissions of zero."

Indirect (market mediated) emissions		
Issue	How should indirect (market mediated) emissions be considered?	
Relevant text in the CRCF	$GHG_{associated}$ is defined in Article 4(1) as "is the increase in direct and indirect greenhouse gas emissions, over the entire lifecycle of the activity which are due to its implementation, including indirect land use change".Recital 8 calls for indirect emissions, including ILUC and displacement effects due to competing demand for energy or waste heat, to be quantified. Recital 10 indicates this should be done in a "relevant, conservative, accurate, complete, consistent, transparent, and comparable manner".	
Relevant approaches in existing methodologies	Some standards require consideration of indirect emissions, but the treatment is inconsistent	
Options	**Pros**	**Cons**
Include all relevant indirect emissions on a case-by-case basis	■ Comprehensive ■ Even treatment across approaches ■ Consistent with a broad interpretation of the CRCF text	■ Indirect emissions, by their nature, are hard to precisely quantify ■ Lack of clarity for some carbon removal activities pending decision on how indirect emissions will be accounted
Include only the indirect emissions mentioned in Recital 8 (ILUC and displacement effects due to competing demand for energy or waste heat)	■ Gives clarity to project developers on which indirect emissions are in scope ■ Consistent with a minimal interpretation of the CRCF text	■ Indirect emissions, by their nature, are hard to precisely quantify ■ Potentially uneven treatment between approaches
Set eligibility criteria to avoid indirect emissions arising, rather than accounting for them in the $GHG_{associated}$ term	■ Avoid issues of imprecision in indirect emission estimates by avoiding indirect emissions	■ Requiring that indirect emissions should be avoided may exclude projects that could deliver net removals after indirect emissions were accounted
Suggested approach		
Preliminary findings	■ The proposed treatment for electricity emissions, which would include consideration of displacement emissions, is detailed in the previous section 2.1.3. ■ For other indirect emissions expected to be material, we suggest that where viable the certification methodologies should set eligibility criteria with a view to avoiding those emissions, so that they may be treated as zero. This should be assessed on an activity-specific basis for each methodology. ■ In some cases, it may not be considered appropriate/possible to avoid indirect emissions. In those cases, quantification approaches should be considered on a case by case basis.	

	■ In the case of displacement of displacement effects due to competing demand for [non-electrical] energy or waste heat, we propose to follow the example of the rigid inputs rules from the Innovation Fund. ■ In the case of ILUC, the Commission has indicated an intention to follow the approach of the RED II. The RED II gives estimated ILUC values for, respectively: cereals and other starch rich crops; sugars; and oil crops. All other sources of biomass are considered in the RED II to have zero associated ILUC emissions. This would be expected to apply to most biomass feedstock for carbon removal projects.
Open questions	■ What indirect emissions other than those explicitly mentioned above might be expected for the carbon removal activities mentioned in section 3?
Next steps	■ Identify relevant indirect emissions to consider in the first batch of certification methodologies developed under the CRCF.

2.1.5 How should uncertainty in project removals be identified and handled?

The provisionally agreed CRCF states in Recital 10 that, “Uncertainties in the quantification should be duly reported and accounted in a conservative manner in order to limit the risk of overestimating the quantity of CO_2 removed from the atmosphere or of underestimating the quantity of direct and indirect GHG emissions generated by an activity”, and in Article 4(8) that, “The quantification of permanent carbon removals … shall account for uncertainties in a conservative manner and in accordance with recognised statistical approaches”, and that, “Uncertainties in the quantification of carbon removals and soil emission reductions shall be duly reported.” This reporting obligation is confirmed in Annex II, while Annex I requires certification methodologies to include, “rules to address uncertainties in a conservative manner in the quantification of carbon removals referred to in Article 4(8)”.

Many existing certification schemes include requirements to characterise uncertainty in net carbon removals assessment. Uncertainties may arise for a variety of reasons, including:

1. Uncertainty due to error margins when physical measurements are taken (e.g. flow measurement for CO_2 captured at a DAC facility);
2. Uncertainty due to potential variation in properties of sampled bulk materials (e.g. uncertainty about whether samples of biochar taken from a larger batch are representative of that batch);
3. Uncertainty in the input data for forward-modelling approaches (e.g. if soil temperature is an input for modelling of biochar losses over 100 years, there will be variation in real soil temperature);
4. Uncertainty about the accuracy of modelling approaches (e.g. if calibration data for a novel approach is limited, such as in the case of enhanced rock weathering [ERW]);
5. Uncertainty about whether reversals are identified (e.g. whether all CO_2 leaks from storage can be detected);

6. Uncertainty about indirect emissions (e.g. what the 'true' ILUC emissions are);
7. Uncertainty due to variability of lifecycle inventory data (e.g. whether the production process used by the supplier of a certain input is consistent with the process assumed in standard inventory data); and,
8. Uncertainty about the potential range of values for an uncertain measurement (e.g. for some indirect emissions it may be difficult to establish a plausible interquartile range and shape of distribution, so that it would not be possible to identify a value at a given percentile of the range).

In some cases, uncertainty can be reduced by specifying measurement rules (e.g. checks on measurement devices, requirement for multiple samples to be analysed from each batch of bulk materials, requirements about how samples should be randomised). In other cases, uncertainty is simply a feature of assessment (e.g. uncertainty in measurements made using best available measurement techniques).

The Isometric standard, as an example, requires that project applicants should provide a characterisation of uncertainty for all parameters considered unless it is demonstrated that that parameter contributes to less than a 1% change in net removals. The protocol requires that uncertainties must be considered so as to generate a conservative estimate of total removals. It states that this should be done through either the adoption of conservative parameter estimates, variance propagation or Monte Carlo simulations. It should be noted that variance propagation and Monte Carlo simulation are only properly possible given a reasonable estimate of the uncertainty in each variable. In some cases, it may be the case that not only is the correct value of the variable not definitively known but that the associated probability distribution is even less known. In such cases, it is possible to impose arbitrary assumptions on variable distribution, but this introduces a degree of subjectivity to the assessment. Without clear specifications on how this sort of uncertainty assessment should be undertaken, there is a risk that it may deliver information of limited value. We note that Isometric's standard anticipates that, as time goes on and data is gathered, it will become increasingly possible to characterise distributions and therefore to apply variance propagation or Monte Carlo simulation in a more meaningful way.

It may be appropriate to adopt different approaches to uncertainty for measured versus modelled inputs, and for values that are calculated using default data (i.e. data taken from some form of lookup table rather than being measured or modelled for the specific project in question). In some cases it may be more useful to focus on requiring operators to seek to reduce the uncertainty in key values than on conducting detailed statistical analysis of uncertainty propagation. For measured values, uncertainty may be reduced by careful specification of measurement requirements.

Handling uncertainty	
Issue	What approach or approaches should be used for assessing and reporting uncertainty in net carbon removals?
Relevant text in the CRCF	The CRCF states in Recital 10 that, "Uncertainties in the quantification should be duly reported and accounted in a conservative manner in order to limit the risk of overestimating the quantity of CO_2 removed from the atmosphere or of underestimating the quantity of direct and indirect GHG emissions

	generated by an activity ", and in Article 4(8) that, "The quantification of permanent carbon removals shall account for uncertainties in a conservative manner and in accordance with recognised statistical approaches".	
Relevant approaches in existing methodologies	Some existing standards require that uncertainty should be assessed in detail, others adopt a principle of conservativism but do not suggest specific uncertainty assessment requirements	
Options	**Pros**	**Cons**
Require operators to characterise uncertainty in all measured, modelled and assumed values, and use this information to ensure net removals estimates are conservative	■ Provide a detailed characterisation of uncertainty ■ Minimise likelihood of overestimation of net removals	■ Greater administrative burden on operators and verifiers ■ In some cases, data on uncertainty distributions may be limited, limiting the value of detailed quantitative analysis
Require consideration of uncertainty only for key parameters identified in the certification methodology for specified carbon removal activities	■ Reduced administrative burden compared to a full uncertainty assessment ■ Aim to capture the major sources of uncertainty for each type of carbon removal	■ A selective approach could in principle fail to identify uncertainties that are collectively significant
Require operators to identify key uncertainties and provide narrative confirmation that they are unlikely to have overestimated removals	■ Reduced administrative burden compared to a full uncertainty assessment ■ Utilises the understanding of the project developers instead of trying to pre-identify all key uncertainties	■ May create an unintended incentive for project developers to downplay uncertainties ■ Qualitative assessment may be difficult to consistently verify ■ May not be fully consistent with the CRCF requirements
Set a general requirement that net removals estimates should be conservative, with implementation devolved to certification schemes	■ Reduced administrative burden compared to a full uncertainty assessment ■ Focus on avoiding overestimation of removals rather than on detailed uncertainty quantification	■ May be difficult to consistently apply and verify ■ May not be fully consistent with the CRCF requirements ■ May create a perverse incentive in favour of schemes that apply light-touch rules on uncertainty assessment
Seek to reduce uncertainty through specification of the measurement and certification requirements, but require no direct uncertainty assessment	■ Reduce burden of uncertainty assessment	■ May not be fully consistent with the CRCF requirements

Suggested approach	
Preliminary findings	■ We suggest that uncertainty could be appropriately handled by requiring key uncertainties to be identified and quantified to the extent possible and by requiring narrative confirmation that net removals are unlikely to have been overestimated. ■ Where activities are subject to key uncertainties that are expected to be common across projects, these should be identified in the relevant certification methodologies.

2.1.6 Should there be a limit on renewals of the activity period?

The provisionally agreed CRCF text defines the activity period in Article 2(1)(ea) as "a period over which the activity generates a net carbon removal benefit or a net soil emission reduction benefit, and which is determined in the applicable certification methodology". It is our understanding that projects would only become subject to any changes in the certification methodologies following renewal of the activity period, and in particular that they would only have to apply adjustments to the standardised baselines (Article 4(5a)) or propose a new activity-specific baseline (Article 4(7)) after renewal of the activity period.

Carbon removals and reduction projects under existing certification schemes are similarly subjected to initial activity periods[17], after which they may be permitted to be renewed for one or more additional activity periods.

Most standards considered apply an initial activity period of between 6 and 11 years for carbon removal projects, though the Drax-Stockholm methodology proposes 15 years. The Article 6.4 mechanism of the Paris Agreement allows an activity period of 15 years for carbon removals, which can be renewed twice[18] (for a total maximum creditable period of 45 years). The agreed text anticipates that activity periods will be defined individually for each certification methodology. It may be appropriate to set shorter minimum periods for some activities, for example in cases where a methodology is adopted for a novel carbon removal technique and the Commission identifies that the certification methodology should be reviewed as the first batches of real world operational, data become available.

Many existing standards limit the maximum number of renewals permitted for a given project. The norm of limiting recertifications was initially adopted for projects in the carbon removals space, and might be seen as related to the use of common practice analysis for emission reduction projects as part of additionality testing in frameworks such as the CDM – after a practice has been applied for a prolonged period and become normalised it may be expected to no longer require carbon financing. In the case of permanent carbon removals, however, the project team sees no compelling general reason to prevent projects from being renewed indefinitely if the market for carbon removals is still active and the project meets certification requirements at the point of renewal of the activity period, including those related to additionality. For example, we see no reason to exclude a DACCS

[17] The activity period is referred to in some standard as the 'crediting period', for example in the UNFCCC Article 6.4 mechanism and standards such as ACR and VCS.

[18] https://legalresponse.org/wp-content/uploads/2022/05/LRI-briefing-2022-1.pdf

project from being recertified for as long it remains active. The provisionally agreed CRCF text does not impose any limit on renewable of the activity periods.

Activity period		
Issue	How many times should projects be permitted to renew the activity period?	
Relevant text in the CRCF	The CRCF anticipates activity recertification but does not explicitly address the question of whether there should be a limit to the number of renewal.	
Relevant approaches in existing methodologies	Most existing standards allow at least one activity period renewal, but the review paper identified only Puro and the ACR CCS methodology as allowing indefinite renewal of the activity period.	
Options – recertification	**Pros**	**Cons**
Allow indefinite renewal of the activity period	■ Allow projects to continue generating carbon removals for as long as they remain viable	■ As an activity gradually becomes an increasingly common practice, there may be a question about whether it truly remains additional
Limit number of activity periods for each project	■ Additional safeguard against approaches that have become common practices being incorrectly identified as additional	■ No clear reason identified to deny renewal of the activity period to permanent carbon removal projects that continue to deliver removals and would pass an additionality assessment
Suggested approach		
Preliminary findings	■ The provisionally agreed CRCF text does not require a limit on activity periods, and the project team sees no compelling reason to impose one.	
Open questions	■ How should the initial activity periods be set in the activity-specific certification methodologies?	

2.1.7 How should baselines (standardised and/or activity specific) be set for the carbon removal activities?

The provisionally agreed CRCF text states in Article 5(1) that “Any activity shall be additional”. To be considered additional it should meet the criteria that “it goes beyond Union and national statutory requirements at the level of an individual operator” and that “the incentive effect of the certification is needed for the activity to become financially viable”. The provisionally agreed CRCF indicates in Article 5(2) that the additionality criteria will be considered to be complied with when a project delivers net carbon removals against a ‘standardised baseline’ (the $CR_{baseline}$ term in the equation for calculating permanent net carbon removal). If a standardised baseline is not available for a given activity, or if a project operator chooses to apply an activity-specific baseline, then Article 5(2) requires that additionality “shall be demonstrated through specific additionality tests in accordance with the applicable

certification methodologies set out in the delegated acts adopted pursuant to Article 8".

The CRCF states that a standardised baseline should reflect the "standard performance of comparable practices and processes in similar social, economic, environmental and technological circumstances and take into account the geographical context, including local pedoclimatic and regulatory conditions." The use of an activity-specific baseline may be required in the case of "lack of data or the absence of sufficient comparable activities". The use of a standardised baseline has some similarity to approaches under existing standards that allow additionality to be assessed through performance standards or a 'positive list'. If the standardised baseline is set to zero for a given activity that is effectively the same as inclusion in a positive list approach, as projects will then be eligible providing that the CR_{total} term in the equation is larger in magnitude than the $GHG_{associated}$ term. Positive list approaches are permitted under the CDM, VCS, GCC, Isometric and the Gold Standard, while performance standards are supported by ACR and VCS.

Setting a standardised baseline requires interpreting how 'comparable activities in similar social, economic, environmental and technological circumstances' should be understood in the context of different permanent carbon removal activities. The adoption of a standardised baseline may be informed by considerations of regulatory surplus and financial viability similar to those involved in a project specific additionality assessment. The CDM 'Combined tool to identify the baseline scenario and demonstrate additionality' provides an example of baseline setting principles[19]

For permanent carbon removals the project team suggests that it would be reasonable to set a standardised baseline of zero for projects for which the value of carbon removal units is the only financial driver or is clearly the primary financial driver (e.g. DACCS). It may be necessary to set a binding or indicative threshold to allow certification bodies to identify whether carbon removal units could be considered 'clearly the primary financial driver', for example for carbon removal units at some benchmark price to represent at least 80% of project revenue. Further consideration would be required to set an appropriate level for such a threshold. In the case that a project type may have other significant revenue streams, a standardised baseline might be based on carrying out the activity but optimising it for other revenue rather than for carbon removal credit generation, or else the use of project-specific baselines could be required. Activities assigned a non-zero standardised baseline in the relevant certification methodologies may be permitted to propose an activity-specific baseline. The provisionally agreed CRCF text states in Article 4(6) that "where duly justified in the applicable certification methodology, including due to the lack of data or the absence of sufficient comparable activities, an operator shall use a baseline that corresponds to the individual, performance of a specific activity ('activity-specific baseline')". The project team considers that it would be duly justified for an operator to apply an- activity-specific baseline in cases where a non-zero standardised baseline is in place but the project operator is able to demonstrate that a lower level of baseline removals would be justified, after satisfying direct additionality tests.

In cases where regional regulatory action is taken to require a carbon removal practice, it may also be necessary to differentiate the standardised baseline by jurisdiction. For example, if a jurisdiction introduced mandatory carbon capture for all

[19] https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-02-v7.0.pdf

bioenergy facilities above a certain output capacity, those facilities should no longer be eligible to generated net carbon removal units under the CRCF.

Setting the standardised baselines		
Issue	How should standardised baselines used to establish project additionality be set?	
Relevant text in the CRCF	Article 5 states that "the baselines shall be highly representative of the standard performance of comparable practices and processes in similar social, economic, environmental, technological and regulatory circumstances and take into account the geographical context including local pedo-climatic and regulatory conditions ('standardised baselines')." Recital 7a states that the standardised baseline should reflect the "standard performance of comparable practices and processes in similar social, economic, environmental, technological and regulatory circumstances and take into account the geographical context including local pedo-climatic and regulatory conditions." Recital 12 states that "if an activity is imposed upon operators by the applicable law, or it does not need any incentives to take place, its performance will be reflected in the baseline."	
Relevant approaches in existing methodologies	Several existing standards allow a 'positive list' or performance standard approach for some technologies, and this is comparable to a standardised baseline.	
Options for standardised baseline (non-exclusive)	**Pros**	**Cons**
Set a standardised baseline of zero for cases where carbon units sales are the only revenue stream	■ Simple in cases where it is clear that carbon removal units are the only revenue source	■ Does not consider local regulatory situation
Set a standardised baseline of zero for cases where carbon units sales are the only revenue stream only in jurisdictions where it has been identified that there is no regulatory requirement for the activity	■ Provides for an element of regulatory surplus testing ■ Simple in identified jurisdictions in cases where it is clear that carbon removal units are the only revenue source	■ Requires regulatory analysis in all potentially relevant jurisdictions
In cases where there are other revenue streams, set a standardised baseline corresponding to optimisation of the project activity for those other revenue streams	■ Avoids over-crediting in cases where projects were likely to happen without the financial incentive of the carbon removals market	■ Projects with other revenue streams would have the burden of undertaking direct regulatory surplus and financial additionality tests if arguing to be allowed a zero baseline
Set a standardised baseline of zero for any carbon removal activity	■ Simple	■ Likely to result in certification of activities that do not need the incentive

that is not identified as a common practice		effect of the certification to become financially viable
Suggested approach		
Preliminary findings	■ We suggest setting a standardised baseline of zero for projects where carbon removal units represent the only revenue stream or are clearly the primary revenue stream. ■ Standardised baselines for other activities should be assessed on a case by case basis with reference to potential revenues.	
Open questions	■ How should 'primary revenue stream' be defined?	
Next steps	■ Developing standardised baseline proposals	

2.2 Additionality

2.2.1 Where a financial test is required, how should the form of the financial analysis be prescribed?

The provisionally agreed CRCF text states that for a project to be additional it must be established that, "the incentive effect of the certification is needed for the activity to become financially viable." If a project is assessed against a standardised baseline then the provisionally agreed CRCF text states that this condition will be automatically considered to be complied with. If, however, the project proposes an activity-specific baseline then the agreed text requires that this should be demonstrated by an additionality test specified in the relevant certification methodology. Determining whether the incentive effect is indeed required for the project to be viable requires an assessment of whether the project would be viable in the absence of an incentive effect. This could be done through a financial additionality test. Most of the standards considered in the review paper allow for some form of financial additionality test as part of the additionality assessment. In several cases, it is prescribed that the CDM investment analysis testing rules should be used. These are detailed in the CDM 'Tool for the demonstration and assessment of additionality'[20] and the CDM 'Methodological tool - Investment analysis'[21].

For financial analysis, key issues relate to the specification of allowable interest rates/required rates of return, and to the information asymmetry between the applicant and the validator. If the financial analysis is undertaken with too low an assumed interest rate it will understate the cost of capital. If the default interest rate is set too high, then it will overstate the cost of capital.

[20] https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-01-v7.0.0.pdf

[21] https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-27-v13.pdf

Design of financial additionality testing		
Issue	What requirements should be set on financial additionality testing?	
Relevant text in the CRCF	The CRCF says in Article 5 that it is required that "the incentive effect of the certification is needed for the activity to become financially viable" and that "where the activity-specific baseline is used, additionality …, shall be demonstrated through specific additionality tests in accordance with the applicable certification methodologies set out in the delegated acts adopted pursuant to Article 8."	
Relevant approaches in existing methodologies	Some methodologies follow the CDM rules, some set relatively broad requirements, some set more detailed requirements	
Options	**Pros**	**Cons**
Follow the CDM investment analysis rules	■ Well established methodology ■ Many verifiers have experience applying this methodology	■ Some experts (e.g. the 2010 Öko-Institut study for DG CLIMA) have queried whether the CDM financial test is reliably able to demonstrate additionality
Develop detailed rules specific to the EU framework	■ Can build on learnings from the CDM and other standards ■ Can focus on carbon removal project types and on the accounting of additional revenue streams	■ A new framework may be seen as adding burden
Develop an outline framework and defer the detail to the certification schemes	■ Greater flexibility for certification schemes to follow existing approaches	■ Risk of inconsistency across different schemes ■ Risk that some schemes may adopt approaches that are not effective at identifying additionality
Suggested approach		
Preliminary findings	■ The CDM investment analysis tool is seen as an appropriate basis for financial additionality testing rules under the CRCF.	
Open questions	■ Are there any aspects in the current CDM requirements that are seen as problematic for carbon removals activities? ■ Should default values for cost of equity in the EU be added to the guidance, given that the CDM tool provides these defaults for developing countries only?	
Next steps	■ Solicit views from the Expert Group ■ Consider whether to incorporate the CDM approach by reference or by copying the relevant elements into the certification methodologies	

2.3 Long-term storage and liability

2.3.1 What is the minimum period of expected carbon storage that may be treated as a permanent removal by the certification methodologies?

The provisionally agreed CRCF text defines permanent carbon removal in Article 2(g) as “any practice or process that, under normal circumstances and using appropriate management practices, captures and stores atmospheric or biogenic carbon for several centuries”. We understand from this that the co-legislators intend that the minimum period considered as permanent carbon storage should be taken as no less than 200 years, and would not need to be longer than 1000 years.

All of the permanent carbon removal certification methodologies considered for the review paper expect carbon storage to have an expected duration of at least 100 years (this is discussed further in the review paper). In all cases, most of the assessed quantity of removed carbon is expected to remain removed beyond the 100-year point, and none of the technologies that are currently being considered for certification methodologies would be expected to be associated with sudden carbon releases after 100 years.

For some carbon removal activities (such as those involving geological carbon storage) the setting of the minimum required storage period would not significantly affect the number of issuable carbon removal units. For these types of removal activity, it may not be relevant to identify a specific timeframe in years for the assessment of the permanence of removals. For other activities, such as biochar carbon removal (BCR) based on biochar incorporation in soils, extending the required period may reduce the number of carbon removal units to be issued as current approaches to estimate the permanence of carbon storage in biochar assume an exponential decay rate over time. For these cases, it may be necessary to set a specific timeframe to allow the calculation of the number of carbon removal units to be issued. In principle, a longer required residence period could be linked to an extending monitoring period, but in practice monitoring requirements may not extend even to 100 years. In the case of geological storage, for example, responsibility for reservoirs and liability for reversals will generally be transferred to the state well before 100 years. In other approaches, active monitoring may not be practical over centurial timescales because of measurement challenges.

Minimum period to be treated as permanent storage	
Issue	The CRCF requires long-term storage of certified removed carbon, but does not state a specific minimum timeframe on which this must be assessed
Relevant text in the CRCF	Article 2(1)(g) states that ‘Permanent carbon removal’ means any practice or process that, under normal circumstances and using appropriate management practices, captures and stores atmospheric or biogenic carbon for several centuries
Relevant approaches in existing methodologies	Most of the existing standards considered frame minimum expectations on a one-hundred-year timeframe, or else address the issue by describing the expected duration of specific removal types

Options	Pros	Cons
A set period (not less than 200 years) identified for all activities	■ Consistent across activities	■ Fails to consider the different character of different carbon removal activities
Activity specific minimum carbon storage, with a minimum of 200 years	■ Allows activity specific details to be considered	■ If a shorter expected minimum removal duration is required for some activities than others this might affect the credibility of the certification for those activities
Suggested approach		
Preliminary findings	■ We suggest that minimum expected storage periods should be set in the certification methodologies on an activity-type specific basis. Where an activity is associated with an expected storage period in another piece of legislation (e.g. the specifications for geological storage under the CCS Directive) then that period should be reflected in the certification methodology.	
Open questions	■ Further consideration is needed on appropriate minimum periods for the activities being considered.	

2.3.2 Should units be issued based on modelled rates of carbon sequestration/carbon reversal?

The provisionally agreed CRCF text states that certification methodologies shall be based on 'best available scientific evidence' and Article 4 (4) states that, "monitoring shall be based on an appropriate combination of on-site measurements with remote sensing or modelling according to the rules set out in the appropriate certification methodologies." We understand this as indicating that it is appropriate to rely on elements of modelling in the certification methodologies on a case-by-case basis.

Certain types of carbon removal project require elements of modelling to be used in order to assess net carbon removals. This may either be to assess persistent carbon storage after a certain time or to establish the rate of carbon removal where it cannot readily be directly measured. This could apply, for examples, to projects using BCR in an agricultural context (as the rate of biochar degradation over a given period is considered predictable but not readily measurable) and projects for ERW (where the removal of CO_2 is not directly observed, but is established based on modelling from scientific principles and proxy measurement). The Expert Group meeting in October 2023 heard technical presentations stating that the rate of persistent carbon removal from BCR and ERW approaches could be established with adequate accuracy to justify certification of those removals. Existing standards that offer certification methodologies for these types of activities have determined that an element of modelling in the carbon removal assessment is acceptable.

It is the view of the project team that EU certification methodologies should allow modelling approaches to be used as part of the assessment of carbon removals where either a) some rate of predictable reversal over time may be expected but

cannot be precisely measured, b) the amount of carbon removed cannot readily be directly observed but is considered reliably predictable, or c) in other circumstances where a modelling approach is considered adequately reliable and direct monitoring would be unduly burdensome. Where modelling approaches are used, they should be based on clear evidence and informed by principles of conservatism – i.e. it should be considered unlikely that the modelling will overestimate the amount of persistent carbon removal.

Modelling in the certification methodologies		
Issue	Should it be acceptable to issue net carbon removal units based on modelling approaches?	
Relevant text in the CRCF	Article 4(4) states that ”monitoring shall be based on an appropriate combination of on-site measurements with remote sensing or modelling according to the rules set out in the appropriate certification methodologies”	
Relevant approaches in existing methodologies	Existing standards for removals through e.g. BCR in soils or ERW rely on elements of modelling for rate of reversal/rate of CO_2 sequestration	
Options	**Pros**	**Cons**
Allow modelling approaches where direct monitoring is not possible or would be excessively burdensome	■ Allows best available science to be used to certify as many approaches as possible	■ It is possible that flaws in modelling approaches could lead to certification of net carbon removals that are not really delivered
Do not allow modelling approaches	■ Only net carbon removals that could be directly monitored would be certified, maximising the confidence in the certified removals	■ Several approaches that are considered robust based on best available science would be excluded
Suggested approach		
Preliminary findings	■ We believe that it is appropriate to rely on elements of modelling in issuing carbon removal units, but that this needs to be established on a case by case basis in the certification methodologies	
Next steps	■ Propose conservative modelling approaches for aspects of the carbon removal assessment that are not readily subject to direct measurement	

2.3.3 Issuance of carbon removal units

The point at which a carbon removal is implemented is not always the same as the point at which a net carbon removal benefit is realised by the atmosphere. For example, in the case of DACCS projects a reduction is atmospheric CO_2 concentration is delivered at the point at which the CO_2 is captured from the atmosphere, but the carbon removal units are generally not issued until the captured CO_2 is injected for permanent geological storage. The issuance therefore occurs a relatively short time after the atmospheric benefit is delivered. For other activities

there may be a more significant time period between the point of implementation of the activity and the point at which a net benefit in reduced atmospheric CO_2 concentrations is delivered.

In the case of biomass-based removals approaches, the timing of delivery of reductions in atmospheric CO_2 concentrations depends on the biomass resources used and the circumstances of their harvesting or collection. Consider three simple examples:

1. If a stand of trees is planted in an otherwise barren area of land in order to produce biomass feedstock then the actual removal of CO_2 from the atmosphere is delivered progressively over the course of several years prior to the implementation of a Bio-CCS or BCR activity. Storing the associated carbon in a geological formation or as biochar does not directly lead to reduction in atmospheric CO_2 but rather confirms the permanence of a removal that has already been delivered.
2. If, in contrast, wood is harvested from a stand of trees that was already in carbon equilibrium and was not planted for this purpose, then the removal of CO_2 from the atmosphere is instead delivered progressively over the course of several years after the implementation of the project activity as trees are regrown on that site. In this case, the point of implementation of the Bio-CCS/biochar activity occurs before the net carbon removal benefit is realised.
3. If biomass is sourced by harvesting agricultural residues such as straw that would have been produced irrespective of the implementation of the activity, then the net carbon benefit is delivered by avoiding emission of carbon from the straw due to natural degradation processes over the course of the subsequent years; if the biomass is sourced by harvesting forestry residues the period over which carbon loss by degradation is avoided could be a decade or more.

It should be noticed that simplified examples such as those above do not reflect some of the complexities involved in establishing temporality when considering largescale forest management systems, where harvest and planting decisions are informed by long-term considerations as well as instantaneous biomass demand. These examples are presented as illustrative of the issues involved, not as characteristic of any specific existing supply chains.

These differences in the timing of avoided biogenic carbon emissions or induced biogenic carbon sequestration are not directly considered in carbon accounting for existing policy measures such as the RED, under which the biomass carbon accounting is based on the UNFCCC inventory principle of counting biogenic CO_2 emissions as zero in industrial inventories because changes in standing biomass carbon stocks are to be dealt with in the land use, land use change and forestry sector.

Biomass-based projects are not the only carbon removal projects where there may be a temporal gap between undertaking a carbon removal activity and the point at which the associated reduction in atmospheric CO_2 concentrations is released. For example, ERW projects may capture CO_2 on a decadal timescale following the point at which rock is applied to agricultural soils. In such a case, the issuance of permanent carbon removal units could be offered either:

- Immediately after that the practice is implemented and certified, and the subsequent rate of carbon removal can be confidently modelled; or,
- Progressively based on cross-referencing in-situ measurements with modelled rates of carbon removal to estimate the actual net carbon removal delivered up to that point.
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For example, the Puro standard for ERW takes the second option, requiring that units should only be issued "based on the actual amount of CO_2 sequestration that has already happened so far".

The provisionally agreed CRCF text states in Article 12(1a) that "Certified units shall be issued … only after the generation of a net carbon removal benefit or net soil emission reduction benefit, based on a valid certificate of compliance resulting from a re-certification audit." For some activities, such as those discussed above, the certification methodologies therefore need to indicate the point at which a carbon removal unit should be treated as being generated. In particular, it must be determined whether a carbon removal unit can be generated at the point that the correct implementation of an activity is verified by a re-certification audit and the delivery of the net carbon removal is adequately certain, or whether a carbon removal unit should only be generated after additional monitoring establishes that the net carbon removal has been physically achieved.

The advantage of allowing units to be generated once the correct implementation of an activity has been demonstrated by a re-certification audit would be that it would reduce the gap between the point at which costs are incurred by a project operator and the point at which certificates are issued. If later monitoring established that the expected removals were not achieved this would then be treated as a reversal. The advantage of allowing units to be generated only after the point at which monitoring or modelling shows that the carbon removal is physically delivered would be that it would avoid the risk of reversals associated with a failure to deliver expected outcomes, and may increase the credibility in the carbon removals market of the generated units. It is noted that it is possible that carbon removal activities may be developed in future that are expected with high confidence to deliver net carbon removals but for which direct monitoring to demonstrate that net carbon removals have physically occurred may not be possible, for example in ocean alkalinity enhancement.

Handling temporality of net carbon removal delivery	
Issue	Different types of carbon removal activity may physically deliver net carbon removals either before or after the point of implementation of the certified activity, and this may affect certificate issuance
Relevant text in the CRCF	Article 12(1a) states that "Certified units shall be issued … only after the generation of a net carbon removal benefit or net soil emission reduction benefit, based on a valid certificate of compliance resulting from a re-certification audit."
Relevant approaches in existing methodologies	No methodology we are aware of differentiates the issuance of removal units for Bio-CCS/BCR projects by reference to the temporality of biomass growth/avoided decomposition (removal units are issued following injection for geological sequestration or on the point of biochar utilisation). The Puro ERW methodology

	requires that the delivery of carbon removals should be demonstrated through monitoring before units are issued.	
Options	**Pros**	**Cons**
Allow issuance only after the net carbon removal has been demonstrated to have physically occurred, including for biomass-based removals	■ Can be seen as fair to all removal activities by allowing revenue generation only after the point that net removal is physically achieved ■ Number of units issued is based directly on monitoring	■ Delays point of revenue realisation for some projects and may make project financing harder ■ Identifying temporality for biomass-based removals may be complex
Issue units for biomass-based removals at the point that carbon physically enters its final storage, for other activities allow issuance only after the net carbon removal has been demonstrated to have physically occurred	■ Bypasses the need for assessment of temporality of biomass removals ■ Can be seen as even treatment among the other types of removal	■ Could be seen as creating uneven treatment between biomass-based and other projects ■ Delays point of revenue realisation for some projects and may make project financing harder
Allow issuance following project implementation without direct demonstration that net carbon removal has physically occurred, on a case by case basis	■ Allows revenue generation for affected activities as soon as possible after project implementation ■ Would allow issuance of carbon removal units to activities that are confidently expected to deliver removals but where removals cannot be directly monitored	■ May be seen as advantaging projects that are associated with delayed carbon removal ■ Demonstrated failure to deliver expected carbon removals would have to be treated as a reversal
Suggested approach		
Preliminary findings	■ At this time, we suggest that the principle of issuing carbon removal units only after the net carbon removal has been physically achieved should be adopted, with the exception of biomass-based removals for which carbon removal credits would be issued following demonstration that carbon has entered permanent storage	
Open questions	■ Are there forthcoming removal activities that would be excluded from the CRCF under this approach but would be reliably expected to deliver net carbon removals?	

2.3.4 What reversal risk assessment should be undertaken for project certification?

Article 6(2) of the provisionally agreed CRCF text states that project operators shall, “be subject to rules to monitor and mitigate any identified risks of reversal occurring during the monitoring period”. Some existing standards include requirements for

project-specific assessment of reversal risk, whereas others implicitly assume that reversal risk is adequately limited by following the requirements for project certification and therefore do not directly require reversal risk assessments.

Where reversal risks are identified it may not be proportionate or even readily possible to use monitoring approaches to determine whether reversals have actually occurred, depending on the activity. It may be impossible to directly monitor for reversals with some carbon removal activities – e.g. in enhanced rock weathering projects it is possible to confirm the disappearance of the material applied as a demonstration that carbon removal can be assumed to have occurred, but it is not possible to directly assess the long-term survival of the sequestered carbon in the marine environment. Similarly, in agricultural BCR projects it is possible to undertake in-field tests to confirm that some biochar remains in situ, but it is not considered readily possible to distinguish by field testing reversals from reductions in biochar concentration due to transport up or down the soil column, across the field, or out of the field entirely. In the case of geological carbon storage, the Drax-Stockholm methodology allows reversal risk assessment to be deferred to local regulation, rather than always requiring a risk assessment as part of the project validation.

The nature of reversal risks is specific to project types, and therefore it may be appropriate to address project-specific reversal risk and reversal monitoring requirements within the individual certification methodologies rather than through standard requirements. As regards reversal monitoring, consideration should be given to maintaining a level playing field between carbon removal activities to the extent possible by seeking to avoid excessive differences in monitoring burden between project types. It would be counter-productive if removal activities where reversals cannot be monitored were made more competitive than approaches where reversals can be carefully monitored because of a reduced burden of monitoring.

Reversal risk assessment		
Issue	What reversal risk assessment should be undertaken for project certification?	
Relevant text in the CRCF	Article 6(2): operators “shall be subject to rules to monitor and mitigate any identified risks of reversal occurring during the monitoring period”. Recital 13: “Operators should take all relevant preventive measures to mitigate those risks [the risk of reversals] and duly monitor that carbon continues to be stored over the monitoring period laid down for the relevant activity. The validity of the certified unit should depend on the expected duration of the storage and the different risks of reversal associated with the given activity.”	
Relevant approaches in existing methodologies	Some standards require project-specific reversal risk assessment, others assume that reversal risk is handled by following the certification requirements.	
Options	**Pros**	**Cons**
Require a full reversal risk assessment from all projects	■ Comprehensive review of reversal risks ■ Leverage understanding of project operators of their project specific risks	■ Difficult to maintain consistent standard across projects, certification schemes and verification bodies

		■ Some operators may undertake low quality assessments
Require risk assessment against reversal risks deemed relevant in each certification methodology	■ Provide clear guidance of which reversal risks should be considered ■ More chance of delivering consistency across the framework	■ May miss some risks relevant to specific projects but not considered in the development of certification methodologies
Suggested approach		
Preliminary findings	■ We suggest that certification methodologies should identify reversal risks that project operators should assess for a given activity.	
Next steps	■ Identify relevant reversal risks for each activity for which a certification methodology is developed	

2.4 Sustainability

2.4.1 How may positive co-benefits be recognised?

The CRCF states in Recital 17 that, “Operators or groups of operators should be able to report co-benefits that contribute to the sustainability objectives beyond the minimum sustainability requirements. To this end, their reporting should comply with the certification methodologies tailored to the different carbon removal activities, developed by the Commission. Certification methodologies should, as much as possible, incentivise the generation of co-benefits for biodiversity going beyond the minimum sustainability requirements, with a view to generate a premium for the certified units, by including for instance positive lists of activities that are deemed to generate co-benefits.”

Co-benefits are framed in terms of six thematic sustainability areas, the same six that are identified as objectives in the EU Sustainable Finance Taxonomy:

1. climate change mitigation (beyond the net carbon removal benefit);
2. climate change adaptation;
3. sustainable use and protection of water and marine resources;
4. transition to a circular economy, including the efficient use of sustainably sourced bio-based materials;
5. pollution prevention and control; and,
6. protection and restoration of biodiversity and ecosystems including soil health, as well as avoidance of land degradation.

Article 7(3) says that, “The certification methodologies shall include elements to incentivise as much as possible the generation of co-benefits going beyond the minimum sustainability requirements”, in particular in regard to biodiversity.

Several existing standards (e.g. CDM, VCS, ACR, Puro) allow for sustainability co-benefits to be listed in/alongside carbon reduction/removal certificates. Several of

these require reporting of co-benefits to use the framework of the sustainable development goals.

The provisionally agreed CRCF does not allow for co-benefits to be encouraged through the issuance of 'bonus' carbon removal units, and therefore there are only two modes available for the certification methodologies to incentivise co-benefits. The first option would be to restrict certification to only projects that generated specified co-benefits. This would be an effective incentive, but it is the view of the project team that this would go beyond the legal powers of the provisionally agreed CRCF, as it is stated that carbon removal projects 'shall' meet a do no significant harm standard but only 'may' deliver co-benefits. The certification methodologies should not present a barrier to efficient carbon removals that do not offer complementary ecosystem services. The only remaining alternative is therefore to provide a robust basis for sustainability co-benefits to be acknowledged and verified in order that they may be valued by the carbon removals market. It is therefore proposed that the certification methodologies should provide a uniform basis to characterise, verify and acknowledge sustainability co-benefits in the areas identified. On top of a framework to identify sustainability co-benefits, it is conceivable that the CRCF could introduce a framework to quantify some level of sustainability achievement – this would be analogous to the identification of substantial contributions to sustainability objectives under the Sustainable Finance Taxonomy (SFT), but may be difficult to deliver consistent treatment of by verifiers.

Recognition of sustainability co-benefits		
Issue	How can the scheme recognise co-benefits given that it would not be permissible to issue 'bonus' carbon removal units in recognition of sustainability performance?	
Relevant text in the CRCF	The CRCF (Article 7) calls for the framework to incentivise carbon removals approaches that deliver co-benefits, in particular with regard to biodiversity	
Relevant approaches in existing methodologies	Several existing methodologies allow co-benefits to be reported, in several cases following the framework of the UN Sustainable Development Goals	
Options	**Pros**	**Cons**
Each certification methodology identifies potential co-benefits and sets protocols for verification of claims to those co-benefits to be verified by certification bodies	■ Provides a defined framework for claims about sustainability co-benefits	■ May exclude important co-benefits of some projects where they are unusual or their identification is novel ■ Does not provide a clear quantified basis for the carbon removals market to compare co-benefit claims
Each certification methodology identifies potential co-benefits and provides some form of scoring system to allow 'substantial contributions' to sustainability to be	■ Provides a defined framework for claims about sustainability co-benefits ■ Provides an explicit market signal in relation to what level of sustainability contribution should be considered substantial	■ May exclude important co-benefits of some projects where they are unusual or their identification is novel ■ There is considerable administrative overhead involved in developing technical screening criteria

identified, and sets protocols for verification of claims to those co-benefits to be verified by certification bodies		for substantial sustainability contributions under the SFT – this would be added to the administrative burden for the Commission of developing new certification methodologies
Operators are given open opportunity to make sustainability claims, which will be verified by certification bodies	■ Allows the widest range of possible sustainability claims	■ It may be difficult to set a consistent verification standard ■ No framework would be provided to the carbon removals markets to assess the value of the claimed co-benefits
Suggested approach		
Preliminary findings	■ We suggest that the activity-specific certification methodologies should identify areas where there is potential to deliver a co-benefit that would be a substantial contribution to a given sustainability area, and provide criteria to allow this contribution to be assessed.	
Open questions	■ Identification of sustainability co-benefits that may be expected for each activity type.	
Next steps	■ Review relevant sustainability contributions identified in the context of the Sustainable Finance Taxonomy.	

3 Modularity and priorities

It is the intention of the Commission and of the project team that the CRCF certification framework will be developed with a modular character, meaning that we identify the elements required for each certification methodology, and where applicable similar or identical handling of specific elements will be applied in multiple certification methodologies. Adopting a modular approach to the development of the certification methodologies should not be understood to imply that each module would correspond to a separate Delegated Act.

Example of modularity in the case of projects involving geological storage of CO_2 are provided by CCS + and by the Climeworks/Carbfix methodology. The CCS+ approach is based on modules corresponding to types of CO_2 capture (the first draft module relates to direct air capture) to CO_2 transport and to types of geological storage (the first draft storage module relates to storage in saline aquifers). The Climeworks/Carbfix system is similarly conceived in terms of modules for types of capture and types of storage, and for transport.

3.1 Priority modules – DACCS and Bio-CCS activities

The Commission has identified the development of certification methodologies for DACCS and Bio-CCS as a priority for 2024. In this context, it is proposed that the following modules will be a focus for work under this ongoing project:

1. Direct air capture, including: chemical or physical absorption or adsorption processed; membrane processes; electrochemical processes; cryogenic processes.
2. Biogenic CO_2 capture from bioenergy plants that does not lead to an increase of the capacity of the plant beyond what is necessary for the operation of the carbon capture and storage.
3. CO_2 transport that meets the requirements of the ETS and CCS Directives.
4. Geological CO_2 storage that meets the requirements of the ETS and CCS Directives

3.2 Other relevant modules and cross-cutting issues

In addition to the four modules identified as priorities above, it is the intention of the Commission that a module for mineralisation of CO_2 in construction material should be developed. There is also ongoing work considering biochar production and use as a carbon removal activity that may lead to the development of relevant modules. Other modules, including those covering other carbon removal activities, will be considered in due course.

Several issues are cross cutting for more than one carbon removal activity, and should be implemented consistently across certification methodologies. This includes accounting for the GHG intensity of consumed electricity, assessing additionality in the case of the use of activity-specific baselines, and setting conditions on biomass use by carbon removal projects. Principles for addressing these issue will be developed in parallel with the development of the priority modules.

3.3 Possible modules for relevant activities

With a longer term view to identifying potentially relevant modules, this section provides a brief review of commonalities across five types of carbon removal activity: DACCS; Bio-CCS; ERW; BCR; and mineralisation in construction material. in the table below, similar activity steps are colour coded as potential modules/cross-cutting issues.

Table 1.1 Sub-processes for carbon removal technologies

DACCS	Bio-CCS	BCR	Mineralisation in construction material	Enhanced rock weathering
Power generation	Biomass production/ collection	Biomass production/ collection	Material production	Rock quarrying and pulverisation
	Biomass transport	Biomass transport		Rock transport
Atmospheric CO_2 capture	Point source CO_2 capture		CO_2 capture	
CO_2 transport	CO_2 transport	Biochar production	CO_2 transport	
Geological CO_2 storage	Geological CO_2 storage	Biochar transport		
		Incorporation in materials	Material treatment with CO_2	
		Biochar application on farm		Rock application on farm
Reservoir monitoring	Reservoir monitoring	Farm monitoring	Monitoring in situ	Farm monitoring

Based on the table, we have identified several potential 'modules' that could be applicable across more than one technology pathway, in addition to those listed above. Other sub-processes are unlikely to be repeated across supply chains. A short discussion on each potential module is presented in the following.

3.3.1 Biomass production/collection

Biomass may be sourced through developing cultivation systems or by collecting residues of other production systems. The RED II provides a framework for biomass use and (in RED II Article 29) sets sustainability requirements on biomass used for energy. Carbon removals from both Bio-CCS and BCR could potentially be thought of as co-products of other systems, e.g. electricity/heat production for BECCS, various other products for other Bio-CCS, and pyrolysis oil production for biochar produced by fast pyrolysis. The status as a co-product raises additional questions about how the environmental burden from feedstock production and acquisition should be allocated.

3.3.2 Bulk material extraction/production

Several carbon removals approaches require some form of bulk material extraction. While the materials in question differ, it may be possible to develop a consistent assessment protocol to assign emissions to these extractive processes.

3.3.3 Bulk material transportation

Bulk material transportation generally requires some combination of road transport by truck, train transport, and sea/waterway transport. It is possible to assign default emissions factors to different types of transportation, or to require operators to make a more specific assessment of the vehicles to be used in a specific case.

3.3.4 Application of materials to soils

Both ERW and BCR may require application of bulk materials (pulverised rock/biochar) to agricultural soils. These materials are quite distinct, but there it may be possible to develop consistent assessment protocols on the sustainability of these activities.

3.3.5 On-farm soil monitoring

There is an open question about how much emphasis the EU certification methodologies will put on post-application monitoring of biochar/rock dust in agricultural soils. In both approaches, it is not expected to be possible to accurately monitor long-term retention of material because of the possibility that material becomes unevenly distributed through the soil column and could migrate vertically and horizontally, and be transported into waterways. In the case of ERW, this transportation is fundamental to the carbon removal activity. Equally, while precise monitoring may not be possible, it might be considered desirable to enforce some basic soil sampling and monitoring protocols in order to provide assurance that initial claims about material application rates were accurate and to monitor the rate of material dispersal. It is not yet clear what these requirements might be, but perhaps there would be a case for some commonality in monitoring requirements across the two approaches.