Application of the CCQI methodology for assessing the quality of carbon credits

This document presents results from the application of version 3.0 of a methodology, developed by Oeko-Institut, World Wildlife Fund (WWF-US) and Environmental Defense Fund (EDF), for assessing the quality of carbon credits. The methodology is applied by Oeko-Institut with support by Carbon Limits, Greenhouse Gas Management Institute (GHGMI), INFRAS, Stockholm Environment Institute, and individual carbon market experts. This document evaluates one specific criterion or sub-criterion with respect to a specific carbon crediting program, project type, quantification methodology and/or host country, as specified in the below table. Please note that the CCQI website Site terms and Privacy Policy apply with respect to any use of the information provided in this document. Further information on the project and the methodology can be found here: www.carboncreditquality.org

Contact
carboncreditqualityinitiative@gmail.com

Sub-criterion:	**1..3.2 Robustness of the quantification methodologies applied to determine emission reductions or removals**
Project types:	**Commercial afforestation** **Establishment of natural forest**
Quantification methodology:	**ACR Afforestation and Reforestation of Degraded Lands, Version 1.2**
Assessment based on carbon crediting program documents valid as of:	**16 May 2023**
Date of final assessment:	**21 February 2024**
Score:	**3**

Assessment

Relevant scoring methodology provisions

The methodology assesses the robustness of the quantification methodologies applied by the carbon crediting program to determine emission reductions or removals. The assessment of the quantification methodologies considers the degree of conservativeness in the light of the uncertainty of the emission reductions or removals. The assessment is based on the likelihood that the emission reductions or removals are under-estimated, estimated accurately, or over-estimated, as follows (see further details in the methodology):

Assessment outcome	Score
It is very likely (i.e., a probability of more than 90%) that the emission reductions or removals are underestimated, taking into account the uncertainty in quantifying the emission reductions or removals	5
It is likely (i.e., a probability of more than 66%) that the emission reductions or removals are underestimated, taking into account the uncertainty in quantifying the emission reductions or removals OR The emission reductions or removals are likely to be estimated accurately (i.e., there is about the same probability that they are underestimated or overestimated) and uncertainty in the estimates of the emission reductions or removals is low (i.e., up to ±10%)	4
The emission reductions or removals are likely to be estimated accurately (i.e., there is about the same probability that they are underestimated or overestimated) but there is medium to high uncertainty (i.e., ±10-50%) in the estimates of the emission reductions or removals OR It is likely (i.e., a probability of more than 66%) or very likely (i.e., a probability of more than 90%) that the emission reductions or removals are overestimated, taking into account the uncertainty in quantifying the emission reductions or removals, but the degree of overestimation is likely to be low (i.e., up to ±10%)	3
The emission reductions or removals are likely to be estimated accurately (i.e., there is about the same probability that they are underestimated or overestimated) but there is very high uncertainty (i.e., larger than ±50%) in the estimates of the emission reductions or removals OR It is likely (i.e., a probability of more than 66%) or very likely (i.e., a probability of more than 90%) that the emission reductions or removals are overestimated, taking into account the uncertainty in quantifying the emission reductions or removals, and the degree of overestimation is likely to be medium (±10-30%)	2
It is likely (i.e., a probability of more than 66%) or very likely (i.e., a probability of more than 90%) that the emission reductions or removals are overestimated, taking into account the uncertainty in quantifying the emission reductions or removals, and the degree of overestimation is likely to be large (i.e., larger than ±30%)	1

Information sources considered

1 American Carbon Registry *Methodology for the Quantification, Monitoring, Reporting, and Verification of Greenhouse Gas Emissions Reductions and Removals from Afforestation and Reforestation of Degraded Land v1.2*, May 2017 (available at:

https://americancarbonregistry.org/carbon-accounting/standards-methodologies/afforestation-and-reforestation-of-degraded-lands)

2 American Carbon Registry Standard, Version 7.0, December 2020 (available at: https://americancarbonregistry.org/carbon-accounting/standards-methodologies/american-carbon-registry-standard)

3 Combined tool to identify the baseline scenario and demonstrate additionality in A/R CDM project activities (AR-TOOL02, Version 01) https://cdm.unfccc.int/methodologies/ARmethodologies/tools/ar-am-tool-02-v1.pdf/history_view

4 Tool for estimation of change in soil organic carbon stocks due to the implementation of A/R CDM project activities (AR-TOOL16, Version 01.1.0). https://cdm.unfccc.int/methodologies/ARmethodologies/tools/ar-am-tool-16-v1.1.0.pdf/history_view

5 Estimation of the increase in GHG emissions attributable to displacement of pre-project agricultural activities in A/R CDM project activity (AR-TOOL15, Version 02.0)

6 Tool for estimation of change in soil organic carbon stocks due to the implementation of A/R CDM project activities (AR-TOOL16, Version 01.1.0)

7 Guidance on application of the definition of the project boundary to A/R CDM project activities (EB44 repan16, version 01)

8 Demonstration of eligibility of lands for A/R CDM project activities (AR-TOOL19, version 02.0)

9 Tool for testing significance of GHG emissions in A/R CDM project activities (AR-TOOL04, version 01)

10 IPCC Good Practice Guidance for Land Use, Land-Use Change and Forestry 2003 (https://www.ipcc-nggip.iges.or.jp/public/gpglulucf/gpglulucf_files/GPG_LULUCF_FULL.pdf)

11 Estimation of non-CO2 GHG emissions resulting from burning of biomass attributable to an A/R CDM project activity (AR-TOOL08, version 04.0.0)

12 Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities (AR-TOOL14, version 04.2)

13 Calculation of the number of sample plots for measurements within A/R CDM project activities (AR-TOOL03, version 02.1.0)

14 CDM Guidelines on conservative choice and application of default data in estimation of the net anthropogenic GHG removals by sinks (version 02)

15 Smith, J. E., Heath, L. S., Skog, K. E. and Birdsey, R. A. (2006). Methods for Calculating Forest Ecosystem and Harvested Carbon with Standard Estimates for Forest Types of the United States. General Technical Report NE-343. USDA Forest Service - Northeastern Research Station. https://www.fs.usda.gov/research/treesearch/22954

The *Erratum and Clarifications* for the ACR methodology were not considered in this assessment, because they do not pertain to the project type being assessed (they only clarify the length of crediting period and how the methodology applies where aggregation or a “programmatic development approach” – equivalent to PoAs – are pursued).

Assessment outcome

The quantification methodology is assigned a score of 3.

Justification of assessment

Note: The ACR methodology for afforestation and reforestation of degraded lands is based on a prior CDM A/R methodology (AR-ACM0001, Version 5.0.0), and relies on many CDM quantification and assessment tools for A/R projects (Sources 11-14). Some of the same potential sources of over- and under-estimation that apply to the CDM AR-ACM0003 methodology also apply to the ACR methodology. However, the ACR methodology includes modifications that address or avoid some potential sources of over-estimation (e.g., by requiring use of regeneration monitoring areas) or introduce potential new sources (e.g., by allowing discretionary use of national, regional, or global data for some parameters, despite indicating “preferred” alternatives.) Where relevant, areas where the ACR methodology aligns with or differs from AR-ACM0003 are noted in this assessment.

Project type

This assessment refers to the following CCQI project types:

Establishment of natural forest

"Establishment of a forest on non-forest land areas that are ecologically appropriate for forests, excluding naturally non-forested biomes and semi-natural grasslands as well as the boreal region due to albedo-effects. The forest will not be used for any commercial purposes, such as harvesting, but may be used for sustainable subsistence. The tree species composition is based on the natural forest type of the area. This project type does not include the restoration of marine coastal ecosystems, such as mangroves."

This is within the scope of the quantification methodology, as the methodology explicitly recognizes reforestation as an eligible activity type that may be implemented on one or more “activity areas” as part of a forest project (Source 1, Section 2.3).

Commercial afforestation

"Establishment of a planted forest on non-forest land areas that are ecologically appropriate for forests, excluding naturally non-forested biomes and semi-natural grasslands as well as the boreal region due to albedo-effects. The forest may be used for commercial purposes such as timber production. The tree species composition may differ from the natural forest type of the area since it follows commercial considerations such as the sales value of the wood. This project type does not include the establishment of agroforestry and marine coastal ecosystems, such as mangroves, nor does it include the management of the project area through community forestry. The project type removes greenhouse gases by increasing forest carbon stocks and possibly carbon stored in harvested wood products.”

This is within the scope of the quantification methodology, as the methodology allows afforestation and reforestation on degraded lands and does not exclude any of the conditions specified for these project types (Source 1).

Selection of emission sources for calculating emission reductions or removals

The ACR methodology requires following the CDM tools for defining a project boundary (Source 7) and demonstrating eligibility of land area(s) included within the project boundary (Source 8). The ACR Standard (Source 2) also stipulates requirements for defining project boundaries relevant to A/R projects. The ACR methodology explicitly identifies the following carbon pools that may or must be accounted for within the project boundary (Source 1, section 2.1):

- Above-ground biomass
- Below-ground biomass
- Dead wood
- Litter
- Soil organic carbon
- Wood products
- Emissions from burning of woody biomass at the time of site preparation

Based on the above, Table 1 indicates whether the methodology addresses sources, sinks, and reservoirs typically included in other afforestation/reforestation methodologies.

Table 1 Assessment of sources, sinks and reservoirs covered

Source, sink, or reservoir	Included in quantification methodology?	Relevant for this assessment?
Above- and below-ground biomass (trees and shrubs)	Yes	Yes. Primary source of removals from the project activity. Also a potential source of emissions at project initiation.
Herbaceous vegetation	No	Yes. Potential minor source of emissions at project initiation (due to removal during site preparation).
Standing dead carbon (carbon in all portions of dead, standing trees)	Yes (or no, if conservative or insignificant)	Yes. May be a reservoir of additional stored carbon. Also a potential source of emissions at project initiation.
Lying dead wood carbon	Yes (or no, if conservative or insignificant)	Yes. Could be a source of emissions at site preparation; could also be a reservoir of additional carbon stored due to the project activity.
Litter and duff carbon (carbon in dead plant material)	Optional (the methodology considers litter to be *a priori* insignificant, but it may be included at project developer's discretion)	Yes. Could be a source of emissions at site preparation; however, removal of litter is prohibited as an eligibility condition. Could also be a reservoir of additional carbon stored due to the project activity.

Source, sink, or reservoir	Included in quantification methodology?	Relevant for this assessment?
Soil carbon	Yes, if site preparation disturbs > 10% of project area. Optional, if exclusion would be conservative or insignificant.	Yes. Could be source of emissions from site preparation activities. The methodology requires accounting for soil carbon if soil disturbance from site preparation affects 10% or more of project area.
Carbon in in-use forest products	Optional	Yes. Harvesting is assumed for commercial afforestation projects.
Forest product carbon in landfills	Optional	Yes. Harvesting is assumed for commercial afforestation projects.
Mobile combustion emissions from site preparation activities	No	Yes. Could be significant source of emissions, depending on scale.
Burning of woody biomass as part of site preparation	Yes (CH_4 emissions only)	Yes. May result in significant emissions of CO_2 and CH_4. CO_2 emissions are accounted for as carbon stock losses, so not separately included in this source.
Mobile combustion emissions from ongoing project operation and maintenance	No	Yes. Could arise from harvesting activities under commercial afforestation projects.
Stationary combustion emissions from ongoing project operation and maintenance	No	No. Not likely to differ from baseline.
Emissions from clearing of forest land outside the project area	Included in methodology requirements to account for leakage.	Yes. Significant potential source of leakage. Afforestation on land currently used for grazing or growing crops may cause displacement of these activities to other lands, leading to a reduction in carbon stocks on those lands (e.g., due to clearing of trees and shrubs).
Emissions/removals from changes in harvesting on forest land outside the project area	No.	Yes. Commercial afforestation could lead to reduced harvesting on other lands (negative leakage), but it is conservative to exclude.
Combustion emissions from production, transportation, and disposal of forest products	No.	Yes. Could be significant in relation to harvesting activities.
Combustion emissions from production, transportation, and disposal of alternative materials to forest products	No. Increased wood product production could displace higher carbon-intensity alternative building materials, like cement or steel. This displacement is	Yes. Potentially relevant where a commercial afforestation project results in wood product production.

Source, sink, or reservoir	Included in quantification methodology?	Relevant for this assessment?
	conservatively not accounted for.	
Emissions from decomposition of forest products	No.	Yes. Potentially relevant for commercial afforestation projects.

The methodology defines a reasonably comprehensive GHG assessment boundary for this project type. Some possibly significant sources of emissions, such as mobile combustion emissions from road buildings and site preparation activities, are not addressed (see further discussion of project emissions/removals, below).

Like CDM AR-ACM0003, the ACR methodology requires accounting for methane emissions from combustion of woody biomass during site preparation activities. Unlike AR-ACM0003, however, N_2O emissions from such combustion are excluded from quantification, on the grounds that they are "negligibly small" (Source 1, Table 1).

Carbon in herbaceous vegetation (which could be released due to site preparation) is not included in the project boundary requirements (Source 1, Table 1). Although not stated explicitly, the methodology treats carbon in herbaceous vegetation as insignificant (similar to AR-ACM0003).

Carbon stocks in both lying and standing dead wood may be excluded from accounting if project developers can show that they are insignificant (using the CDM "tool for testing significance of GHG emissions in A/R CDM project activities" – Source 9) or can demonstrate using "transparent and verifiable information" that the project is likely to increase carbon in this pool relative to the baseline scenario. While procedures and criteria for the latter option are not defined, the approach is nevertheless more conservative than CDM AR-ACM0003, for example, which allows optional exclusion of these reservoirs without a justification.

A similar approach is indicated for carbon stocks in litter (Source 1, Table 1). However, the methodology notes in a footnote (Source 1, footnote 2, p. 13) that the ACR Standard considers litter to be *a priori* insignificant, suggesting that projects may automatically exclude this pool at their discretion. Section 2.5.1.3 of the ACR methodology also indicates that quantification of carbon in litter is only necessary "if selected in Table 1." Because of this implied exemption, discretionary exclusion could be a source of overestimation for some projects (see further discussion of project emissions/removals, below).

Accounting for carbon stored long-term in harvested wood products (both in-use and in landfills) is optional. Exclusion would be conservative, since an increase in harvest due to the implementation from a commercial afforestation project may (on balance) increase the amount of carbon stored in these pools, relative to the baseline. For this assessment, it is assumed that carbon stored in harvested wood products is included in the overall quantification of net removals.

Determination of baseline emissions/removals

Baseline scenario identification and modeling

Like the CDM AR-ACM0003 methodology, the ACR methodology requires project owners to conduct an assessment of possible baseline scenario alternatives – and identify a baseline scenario – using the CDM "Combined tool to identify the baseline scenario and demonstrate additionality in A/R CDM project activities" (Source 3). Alternatives must include continuation of pre-project land use, forestation without being registered as a project activity (i.e., BAU forestation), and BAU increase in forest cover (partial forestation) due to legal requirements or common practice activities (paragraph 9 of the tool).

U1 Despite the requirement to identify a baseline scenario, there is no discussion of how baseline *carbon stock* estimation should be informed by the baseline scenario identified. The presumption seems to be that only one scenario – continuation of pre-project land use – will be identified in applying the CDM combined tool; however, the methodology does not explicitly state that it is only applicable if this scenario is identified as the most plausible scenario. In the main section prescribing methods to estimate baseline carbon stocks (Source 1, section 2.4), for example, there is no mention of the possibility of baseline tree planting activities and how these are to be modelled. This may be reasonable for a large majority of projects on degraded lands, but the lack of clear guidance creates uncertainty in how other possible scenarios (e.g., partial reforestation due to changing legal requirements, anticipation of meeting NDC or LEDS targets, or other drivers) would be addressed.

U2 The failure to consider alternative baseline scenarios **is to some extent remedied by a separate requirement to establish "regeneration monitoring areas"** (Source 1, section 3.3). These areas are used as control areas to verify, on ongoing basis, the validity of baseline assumptions about tree growth and regeneration in the absence of the project activity. Under the ACR methodology, "[i]f the observed number of seedlings per hectare exceeds the baseline estimate by more than 10% and by more than 10 trees per hectare, the baseline scenario … must be modified to better reflect the observed values." In principle, the requirement to use these monitoring areas could capture any baseline tree planting activity or natural regeneration that might have occurred due to changing legal requirements, policy, or common practice (as well as any natural regeneration that diverges from initial assumptions, regardless of policy or practice changes). However, the methodology does not explicitly address these issues, and there are limited prescriptive requirements around how regeneration monitoring areas should be defined and selected (e.g., the methodology indicates only that such areas must be "similar to" the project area in characteristics such as soil type, slope, aspect, and distance to seed sources. **Because it is not clear how well the use of regeneration monitoring areas would work in practice to capture deviations from baseline assumptions, the net effect is unknown.**

OE1 One potential issue with the prescribed approach for using regeneration monitoring areas is that these areas must only be re-assessed at intervals of 10 years (Source 1, Section 3.3) and any revisions to baseline assumptions that result from this reassessment are strictly forward-looking – that is, baseline revisions "will not be applied retroactively to credits already verified and issued in earlier years." This provision may not pose a problem for a project's initial verification, which may be deferred up to 10 years (so that when the regeneration areas is assessed, it would coincide with a project's first credit issuance.) However, it may pose risks for subsequent credit issuances, which may occur on more frequent intervals than 10 years. While this provision is understandable from the perspective of providing assurances to project owners and credit holders, it could still lead to over-crediting in years before it is discovered that the original baseline assumptions were inaccurate.

U3 The ACR methodology notes that "changes in carbon stock of above-ground and below-ground biomass of non-tree vegetation" (as well as dead wood and litter) "may be conservatively assumed to be zero for all strata in the baseline scenario." This assumption could be plausible for projects on land that is in the process of degrading, but no rationale is provided for why this is conservative as a general assumption (see U1, above). A conservative approach might require using optimistic assumptions about net growth in these pools in the baseline scenario. It seems possible, however, that the authors of the methodology meant to suggest that it is conservative to assume there will be *no difference* in baseline vs. actual carbon in these pools (since the methodology notes they may be "conservatively" assumed to not change in the project case as well, apart from disturbance by site preparation activities). This would be conservative because reforestation/afforestation activities would typically enhance carbon in these pools over time relative to the baseline. Given the lack of clarity around this, this is assessed as a source of uncertainty. If the methodology were to more clearly specify that project developers must assume no change in in baseline vs. actual carbon stocks, **this could be assessed as a source of underestimation**.

However, it should be noted that **according to the terms of the methodology as written**, a project developer might "conservatively" assume zero change for these pools in the baseline, while measuring and monitoring any increases due to the project, thus (potentially) over-estimating total removals. The equations and procedures for estimating baseline carbon stocks (section 2.4) refer only to carbon in trees and long-term wood products, and omit any reference to baseline carbon in other carbon pools (except briefly in the introduction to section 2.4), whereas the procedures for measuring project-case carbon (section 2.5) explicitly include formulas for estimating carbon in these other pools. **This lack of specificity in the methodology related to baseline carbon stocks in non-tree vegetation could therefore potentially lead to uncertainty.**

OE2 The methodology allows considerable flexibility in determining when a "steady state" would be reached in the baseline scenario, at which point there is assumed to be no net increase in baseline carbon stocks (i.e., zero ongoing baseline removals). Specifically, project owners may, "on a project specific basis," determine when a steady state would have been reached "on the basis of transparent and verifiable information" from a variety of potential sources. In the absence of such information, the default is assumed to be 20 years. Without any further assessment or validation, however, project owners could choose this default under conditions when a steady state might occur further into the future, or make a case that the steady state would occur sooner. Either option could result in an underestimation of baseline removals and therefore overestimation of net removals due to the project. Given that projects are implemented on degraded lands, this is estimated to apply only to a small number of projects and have a low impact on total credited removals.

Measurement and quantification of baseline carbon stocks

For estimating both baseline and project carbon stocks, the ACR methodology requires appropriate stratification by tree and vegetation type when developing inventories (Source 1, section 2.3). Although stratification requirements and guidelines are provided in the context of baseline carbon stock estimation, the methodology notes that stratification approaches may differ for baseline and project-case estimates, due to differing vegetation and tree-species mixes. This is an appropriate approach. However, the methodology provides significant flexibility in quantifying baseline carbon stocks and removals.

OE3 The methodology allows flexibility in choosing methods to estimate both initial carbon stocks (including use of default parameters; Source 1 sections 2.4.1 and 2.4.2) and biomass increments over time (including use of IPCC approximation tables; Source 10.) Furthermore, several parameters used in baseline quantification (whose values are not monitored, e.g., values for tree growth rates, wood density, and carbon loss rates) may be quantified using a range of data sources, from local or national data to regional or global (IPCC) data sets (Source 1, section 2.8). The range in values that may be used (depending on data availability and discretion of the project developer) could be significant, leading to potentially significant variation in quantification among projects. This flexibility makes sense in order to accommodate a wide variety of locations, ecosystems, and tree species around the world. However, the methodology does not explicitly require using the most accurate (or, if not accurate, more conservative) parameter values. For example, the methodology indicates that locally and regionally specific data are "preferred," but there is no hard requirement to use preferred alternatives, meaning that project developers could, in principle, adopt less accurate but more favorable parameter values. As one example, a range of studies suggest that use of different allometric equations could lead to significant under- or over-estimation of above-ground biomass in trees (Ngomanda et al. 2014; Alvarez et al. 2012; Chave et al. 2014; Temesgen et al., 2015; Fonseca et al., 2012; Pati et al., 2022). Use of different methods for initial carbon stocks and biomass increments over time could be a source of over- or under-estimation, depending on actual tree species present and methods used. However, since project developers can essentially choose from a broad range of values, there is a risk that they will choose favourable values and methods, contributing to underestimation of baseline carbon stocks and removals, and therefore an over-estimation of net removals due to the project. It is not clear for how many projects this issue leads to overestimation.

Other baseline emissions

UE1 **Exclusion of displaced emissions from wood product alternatives**. The methodology conservatively excludes accounting for baseline emissions from the production, use, and disposal of wood product alternatives (such as concrete used in buildings), which might be displaced by wood products from commercial afforestation projects. This could result in a (likely small) underestimation of total net emission reductions and removals from a project.

Determination of project emissions/removals

The ACR methodology quantifies net project-case removals by quantifying the change (increase) in carbon stocks in required and selected carbon pools: trees, non-tree vegetation, dead wood, litter, soils, and harvested wood products (Source 1). In addition, the methodology requires accounting for certain project-case emissions associated with site preparation before tree planting occurs (although some potential sources are omitted).

Note: Net removals due to the project are calculated as the difference between (1) the *increment* in actual (project case) carbon stocks and any increment assumed in baseline carbon stocks over a given reporting period. This is equivalent to the difference between project-case removals and baseline removals achieved over the reporting period (Source 1, Section 2.7). Any project-case emissions must be subtracted from net removals to determine creditable emission reductions/removals (although this is not made entirely clear in Section 2.7.1 of the methodology, which provides the formula for calculating the quantity of credits that may be issued).

Site preparation emissions

Accounting for site preparation emissions from clearing and burning of existing biomass is required. The ACR methodology requires accounting for loss of shrubs due to site preparation using the CDM tool "Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities" (Source 12). The methodology is not explicit about quantification of any loss in dead wood due to site preparation; however, tracking of carbon in dead wood is required unless it can be demonstrated that: (1) carbon in these pools is insignificant (using Source 9); or (2) carbon in these pools is unlikely to be lower over time in the project case than it would have been in the baseline scenario (Source 1, Table 1). Any loss of carbon in litter due to site preparation is excluded by default, unless project owners choose to include it. Since removal of litter is prohibited as an eligibility condition, this does not result in potential overestimation.

If biomass is burned during site preparation activities, then non-CO_2 emissions from combustion of biomass must be estimated using the CDM tool "Estimation of non-CO2 GHG emissions resulting from burning of biomass attributable to an A/R CDM project activity" (Source 11).

OE4 However, N_2O emissions from combustion of onsite woody biomass during site preparation may be ignored. The methodology indicates that these emissions are "negligibly small." This contrasts with CDM AR-ACM0003, which requires accounting for both methane and N_2O emissions. Excluding N_2O emissions could result in slight overestimation of net emission reductions/removals.

OE5 Finally, in line with the CDM AR-ACM0003 methodology, the ACR methodology does not require accounting for mobile combustion emissions from site preparation activities. The CDM AR-ACM0003 methodology considers these sources to be insignificant; however, significance may depend on site-specific circumstances. Exclusion could therefore be a source of overestimation of net reductions/removals.

Other emissions

OE6 **Exclusion of harvesting- and wood product-related emissions**. The methodology excludes accounting for emissions from multiple potential sources associated with harvesting and wood product production (see Table 1). These include combustion emissions from equipment used in harvesting activities, and emissions from the production, transportation, and disposal of wood products. They also include potential non-CO_2 emissions from decay of harvest wood products over time. These emission sources are expected to be small for a typical project. However, their exclusion could contribute to overall overestimation of net removals for commercial afforestation projects.

Quantification of project-case onsite carbon stocks and removals

The ACR methodology allows use of multiple methods for estimating carbon stocks, including a Forest Vegetation Simulator model developed by the US Forest Service. All methods require appropriate stratification of carbon pools to be measured. Sample plots required for each method must be determined using the CDM tool "Calculation of the number of sample plots for measurements within A/R CDM project activities" (Source 13).

The methodology allows project developers to "conservatively" assume zero net change in project-case non-tree vegetation carbon, except where site preparation results in emissions from this pool. However, this would only be conservative if non-tree vegetation carbon stocks in the project-case are in fact likely to increase – see discussion under OE2, above. If zero net change is not assumed, projects may estimate carbon in non-tree vegetation using the CDM tool "Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities" (Source 12).

OE7 As with baseline estimation, several parameters used in quantification whose values are not monitored (e.g., values for tree growth rates, wood density, and carbon loss rates) may be quantified using a range of data sources, from local or national data to regional or global (IPCC) data sets (Source 1, section 2.8). The range in values that may be used (depending on data availability and project discretion) could be significant, leading to potentially significant variation in quantification among projects. The methodology indicates that locally and regionally specific data are "preferred," but there is no hard requirement to use preferred alternatives, meaning that project developers could, in principle, adopt less accurate but more favorable parameter values. (By contrast, the CDM AR-ACM0003 methodology prescribes default values for many of these same parameters, which may improve consistency – and avoid gaming - at the expense of accuracy.)

For example, a range of studies suggest that use of different allometric equations could lead to significant under- or over-estimation of above-ground biomass in trees (Ngomanda et al. 2014; Alvarez et al. 2012; Chave et al. 2014; Temesgen et al., 2015; Fonseca et al., 2012; Pati et al., 2022). Another potentially significant element is the carbon fraction of tree biomass. The ACR methodology indicates a "preference" for using species-specific ratios of carbon mass to biomass in trees (Source 1, Section 2.8). However, it does not exclude choosing an IPCC default value of 0.5. At least one study suggests that using a ratio of 0.5 could significantly overestimate carbon stocks in a variety of tree species (especially angiosperms) in different climate zones (Martin et al. 2018). Since project developers can essentially choose from a range of values, there is a risk that they will choose favourable values and methods, contributing to overestimation of project carbon stocks and removals, and therefore an over-estimation of net removals due to the project. It is not clear for how many projects this issue leads to overestimation.

U4 Quantification of soil carbon is not required unless site preparation activities result in soil disturbance across 10% or more of the project area. If a project is implemented on organic soils or wetlands, then soil disturbance on greater than 10% of the project area results in ineligibility – Source 1, section 1.4. These requirements are common across other A/R methodologies (including CDM AR-ACM003 and the Climate Action Reserve Forest Project Protocol). They assume that if soil disturbance occurs on less than 10% of the project area, emissions will be insignificant (even for projects on organic soils). This may not be true in all cases; further research is needed to examine this question. The net effect is therefore deemed uncertain.

U5 Project developers may optionally include estimates of soil carbon (e.g., if they expect the project may significantly enhance the soil carbon pool). If project developers choose to include quantification of soil carbon, they must use the CDM "Tool for estimation of change in soil organic carbon stocks due to the implementation of A/R CDM project activities" (Source 6). Under this tool, estimation of the increase in soil organic carbon (SOC) is based on the assumption that "implementation of an A/R CDM project activity increases the SOC content of the lands from the pre-project level to the level that is equal to the steady-state SOC content **under native vegetation**." The approach uses default reference levels for SOC in different types of soils and regions under native vegetation. Initial SOC is determined using these same defaults, adjusted using additional default discount factors to determine (typical) starting SOC values based on baseline land use, management, and nutrient input regimes. This is a highly "standardized" approach (little to no actual measurement is involved). This reduces costs given the significant effort required to measure SOC. However, whether the results are conservative is difficult to determine without knowing more about project-specific circumstances. For the project type being assessed here (which involves planting of native tree species, as assumed in Source 6), it could be reasonably accurate. However, the overall effect is difficult to assess without knowing project-specific circumstances.

UE2 Finally, Section 3.5 of the AC methodology stipulates that “while applying the methodology” (e.g., in quantifying both baseline and project-case emissions and removals) project developers shall ensure that – where uncertainties exist – they apply the CDM “Guidelines on conservative choice and application of default data in estimation of the net anthropogenic GHG removals by sinks” (Source 14). All else equal, this could result in underestimation of net removals/reductions. However, the ACR methodology’s guidance here is minimal, and less explicit than other A/R methodologies that prescribe the application of uncertainty discounts (for example) to ensure conservative quantification of net removals. In particular, the ACR methodology indicates only that project developers “should” select values that lead to *accurate* quantification, and use conservative estimates only where uncertainty is “significant.” The effect of this element is therefore deemed to be low (and could, in practice, serve mainly to avoid substantial *overestimation* associated with other elements identified above).

Determination of net long-term carbon storage in harvested wood products

For projects that involve harvesting of planted trees, the ACR methodology allows project proponents to account for additional carbon stored in harvested wood products over the long term. At each verification, any *additional* amount of carbon stored in wood products due to harvesting is calculated (i.e., net of any amount that was quantified previously). The amount that may be credited is equal to the quantity of additional carbon that is expected to remain stored (either in in-use wood products, or in wood that has been discarded in landfills) after a period of 100 years.

WP_UE1 Actual carbon stored in harvested wood products in the short- and mid-term (e.g. within ACR’s minimum period of 40 years for ensuring non-permanence) may substantially exceed the amount estimated to remain after 100 years. Thus, estimating and crediting only the amount that remains after 100 years conservatively underestimates net removals relative to ACR’s minimum commitment period. In the long-term, however, a large fraction of carbon stored in any given cohort of wood products will eventually be re-emitted to the atmosphere (a small but uncertain percentage may remain stored in landfills for very long time periods). For this reason, this assessment does not factor underestimation due to the use of 100-year storage values into the overall assessment of robust quantification. (In other words, for the purposes of this assessment, use of 100-year values is considered as neither an under- nor overestimate of net removals.)

The ACR methodology recognizes two methods for determining the quantity of carbon stored in harvested wood products after 100 years: the “1605(b)” method (which provides data and guidance specific to the United States) and the Winjum method (which may be applied globally). There are several potential sources of uncertainty and (likely) overestimation of the amount of carbon stored associated with these methods.

WP_OE1 The methodology permits the assumption that no baseline production of wood products will occur from trees within the project area. This may be reasonable for many A/R projects on degraded lands, but may not be a plausible assumption for all such projects. Project developers have the option to estimate baseline harvesting and include this in their baseline carbon pool estimates (Source 1, section 2.4.3). Where this is identified as a plausible component of the baseline scenario (which might be true for a small fraction of potentially eligible projects), it should arguably be required and not optional. This provision may thus lead to a potential overestimation of net removals. Furthermore, to avoid overestimation, the methodology should require that baselines assume either the same mix of products as produced by the project, or a more durable mix of wood products.

WP_OE2 Whichever method is used, project proponents are required to determine the cumulative sum of biomass extracted (harvested) from each stratum within the project area up to the current year, along with the density of extracted wood and the types of wood products produced. However, no guidance is provided on how to measure extracted volumes, what degree of precision is required, or how this data should be monitored and verified. Likewise, there is no guidance on determining wood density or how to determine (and verify) the mix of wood products produced (e.g., sawnwood vs. pulpwood). The methodology notes that the Forest Vegetation Simulator may be used to determine these quantities, but no guidance is provided concerning determination of the inputs required for this tool. The lack of guidance means there could be leeway in terms of how quantities of extracted biomass and product mixes are determined, which could lead to significant variability (and uncertainty) in long-term carbon stock estimates. Since project proponents have leeway here, they may be expected to choose favorable measurement methods and (especially) product mix assumptions (e.g., assuming a greater proportion of harvested wood goes into more durable products), which could lead to some overestimation of removals. The significance of potential overestimation, however, is unclear without further analysis and understanding of actual practice (including verification).

WP_OE3 Whichever method is used, the methodology ignores any potential displacement of wood production from other forest lands. Instead, the methodology counts as a removal all carbon remaining after 100 years in wood products produced from the project area. This fails to take into account any market response to the increase in wood production resulting from the project. If demand for wood products is not perfectly elastic (which is likely), then any increase in wood production from the project is likely to lead to a reduction in production somewhere else (all else equal). Total net removals will therefore be less than the total quantity of carbon in harvested wood products produced by the project itself. Failure to account for market displacement could therefore lead to overestimation of removals associated with the harvested wood product pool, in some cases quite significantly.

WP_OE4 To determine the carbon content of harvested biomass, the methodology requires using a 0.5 carbon fraction (there is no option to use other values, and unlike for onsite carbon stocks, the methodology does not indicate a preference for species-specific values). As noted for OE8, use of a 0.5 carbon fraction could significantly overestimate the ratio of carbon for a variety of species and climate zones. This could lead to significant overestimation of carbon remaining long-term in wood product pools.

WP_U1 The amount of carbon that remains stored in wood products after 100 years may be determined using multiple methods. Both the 1605(b) and Winjum methods provide estimates (based on prior studies) indicating the amount of extracted carbon that can be expected to remain stored in in-use wood products and in landfills after 100 years, accounting for loss and decomposition over time. The 1605(b) estimates were derived for different types of wood products from different types of trees (hardwood or softwood) produced in different regions of the United States (Source 15). The Winjum approach may be applied globally. It differentiates between four different product types and three forest types (based on climate), and applies different assumptions for production waste in developed vs. developing countries (Source 1). A key source of uncertainty is that the data used for these estimates are essentially backward-looking. Data for both methods were collected more than 20 years ago (the Winjum study is from 1998), were based on surveys of the disposition of wood products produced in prior decades, and are representative of use and disposal trends over the prior century. It is not certain that wood products produced today will have similar longevity as those produced earlier. Nor it is clear that future landfilling rates for wood products will look similar to trends over the past 100 years (to the contrary, one could expect these trends to change significantly with the development of circular economy measures and more sustainable waste management practices). In addition, the Winjum method does not align with more recent IPCC methods, in particular in the 2019 Refinement to the 2006 IPCC Guidelines for National GHG Inventories. The study behind the 1605(b) method notes that key variables behind the estimates may fluctuate regularly.[1] As such, the estimates are properly seen as approximate, with potentially large error bars.

WP_OE5 In addition to the uncertainties in estimating carbon stored in wood products (WP_U1), the ACR methodology allows project proponents to choose between the identified methods (1605(b) or Winjum). In addition, if opting for the Winjum method, project proponents may substitute their own data for various parameters if the data are from "from local, regional, or national sources that can be validated by peer-reviewed literature." These various options introduce the opportunity for "gaming" – especially for projects located in the United States – as project proponents could choose whichever method and/or set of data provides them with the highest estimate of long-term carbon storage. This could lead to overestimation of net removals in wood products, though the magnitude of overestimation is not known.

WP_OE6 At each verification, the ACR methodology allows quantification and crediting of any additions to the wood product carbon pool due to harvesting since the prior verification. The amount credited (as a removal) is based on estimates of how much of the newly extracted biomass will remain in wood products after 100 years from the date of verification. However, the method does not adjust for any decay after 100 years in the wood product carbon pool associated with prior harvests. Instead, it effectively assumes that there is no further decay. This leads to overestimation (all else equal), because the total amount of carbon stored in wood products associated with prior harvests will (in actuality) continue to decline. A more accurate approach would be to calculate a rolling estimate of net carbon remaining in the wood product pool after 100 years, taking into account both inflows (from new harvests) and outflows (from continued decline of carbon associated with older harvests).

Overall net effect:

OE8 Overall, the potential sources of overestimation for carbon stored in wood products – especially from elements WP_OE2 and WP_OE3 – are significant. However, the resulting contribution of this overestimation to estimates of *total* net removals associated with a typical commercial afforestation project is difficult to determine, because this will depend on the amount and frequency of harvesting. Variability in harvesting regimes among projects could be significant; however, because heavy

[1] For example, the study notes that "the link between forest and sequestration in products may be less clear when starting from primary wood products. Forest composition, site conditions, and climate differ by regions, and climate, timber markets, and forest management priorities are subject to change from year to year" (Source 15).

harvesting would likely result in a reversal, the potential impact is assessed as moderate Note that the overall degree of overestimation associated with carbon stored in wood products depends on assumptions about the actual proportion of wood product carbon that is likely to remain stored over time (which is subject to uncertainty), as well as the time horizon considered. Overestimation may be smaller in the short term, given that the methodology only accounts for carbon that is expected to remain stored after 100 years. Over the longer term, the amount of overestimation is likely to be more significant.

Determination of leakage emissions

Leakage associated with reforestation projects can occur if reforestation displaces other land uses, e.g., by converting agricultural land to forest land, leading to a displacement of agricultural production. Under the ACR methodology, leakage must be calculated using the CDM tool for "Estimation of the increase in GHG emissions attributable to displacement of pre-project agricultural activities in A/R CDM project activity" (Source 5).

U6 Under the tool, agricultural activities are assumed to be displaced to other forested land areas on a one-for-one basis. That is, if 10 hectares of land in the project area were previously used for cropland, then it is assumed that 10 hectares of forest land will be cleared elsewhere to accommodate the displacement of cropping activity. This may or may not be conservative, depending on circumstances. On the margin, net agricultural activity may decline if there are costs associated with shifting to other land areas, which could lead to less than one-for-one displacement of other forest land. On the other hand, if receiving land areas are less productive, this could lead to clearing of *more* forest land than the area that was planted in trees. The actual net effect would be hard to determine without knowing project-specific circumstances (and even so, may be hard to estimate). This approach is therefore deemed to introduce considerable uncertainty.

OE9 Some exceptions are made for displacement of grazing activities, e.g., displacement of project area grazing to other grassland areas that are capable of supporting more intense grazing. These exceptions are reasonable. However, determining to where pre-existing grazing activities are displaced may be subject to uncertainty (it may be difficult to monitor in some cases), which could make application of these exceptions somewhat subjective. Because of this, allowing such exceptions could in some cases lead to overestimation of net removals.

U7 The amount of carbon that is emitted from receiving land areas is determined either through direct measurement (assuming project proponents can determine where these areas are located) or through use of IPCC default numbers for average forest carbon stocks in different regions and countries (i.e., using Table 3A.1.4 of the IPCC Good Practice Guidance for Land Use, Land-Use Change and Forestry (IPCC 2003)). Again, it is difficult to determine *a priori* whether the approach is conservative. There could easily be uncertainty in trying to determine precisely where agricultural activities are displaced to, and therefore whether a measurement approach is accurate or conservative. When using defaults, however, it is difficult to know without further information whether they would be conservative for a specific project. The effect of this element is therefore uncertain.

UE3 **Exclusion of "negative" leakage**. The methodology conservatively excludes any accounting for displaced harvesting on other forest lands that might occur as a market response to wood product production from a commercial afforestation project. Any increase in carbon stocks on other forest land due to the project would be difficult (or impossible) to monitor. However, not accounting for this displacement effect could lead to some underestimation of total net removals due to the project.

Summary and conclusion

This assessment has two sections. Table 2 summarizes the overall assessment of the ACR methodology, taking into account all identified elements discussed above, including the overall assessment of methods used to account for carbon in harvested wood products (OE9). Table 3 summarizes the assessment of sub-elements associated with the wood product carbon pool (the net effect of which is summarized in OE9 in Table 2).

Table 2 Relevant elements of assessment and qualitative ratings

Element	Fraction of projects affected by this element[2]	Average degree of under- or overestimation where element materializes[3]	Variability among projects where element materializes[4]
Elements likely to contribute to overestimating emission reductions or removals			
OE1 Lack of retroactive baseline revisions from reassessment of regeneration monitoring areas	Low	Low to Medium	Medium (depends on length of time between monitoring area reassessments)
OE2 Flexibility in specifying when a "steady state" of zero baseline carbon removals is reached	Low	Low	Medium (depends on baseline removal potential)
OE3 Possibility to choose advantageous values and methods for quantifying	Unknown	Low to Medium	High

2 This parameter refers to the likely fraction of individual projects (applying the same methodology) that are affected by this element, considering the potential portfolio of projects. "Low" indicates that the element is estimated to be relevant for less than one third of the projects, "Medium" for one to two thirds of the projects, "High" for more than two third of the projects, and "All" for all of the projects. "Unknown" indicates that no information on the likely fraction of projects affected is available.

3 This parameter refers to the likely average degree / magnitude to which the element contributes to an over- or underestimation of the total emission reductions or removals for those projects for which this element materializes (i.e., the assessment shall not refer to average over- or underestimation resulting from all projects). "Low" indicates an estimated deviation of the calculated emission reductions or removals by less than 10% from the actual (unknown) emission reductions or removals, "Medium" refers to an estimated deviation of 10 to 30%, and high refers to an estimated deviation larger than 30%. "Unknown" indicates that it is likely that the element contributes to an over- or underestimation (e. g. overestimation of emission reductions in case of an omitted project emission source) but that no information is available on the degree / magnitude of over- or underestimation. Where relevant information is available, the degree of over- or underestimation resulting from the element may be expressed through a percentage range.

4 This refers to the variability with respect to the element among those projects for which the element materializes. "Low" means that the variability of the relevant element among the projects is at most ±10% based on a 95% confidence interval. For example, an emission factor may be estimated to vary between values from 18 and 22 among projects, with 20 being the mean value. "Medium" refers to a variability of at most ±30%, and "High" of more than ±30%.

Element	Fraction of projects affected by this element[2]	Average degree of under- or overestimation where element materializes[3]	Variability among projects where element materializes[4]
baseline carbon stocks in trees and woody biomass			
OE4 Exclusion of N_2O emissions when calculating emissions from combustion of woody biomass at site preparation	High	Low	Low
OE5 Exclusion of mobile combustion emissions from site preparation	High	Low	Low
OE6 Exclusion of harvesting- and wood product-related emissions	High for commercial afforestation projects N/A for establishment of natural forest	Low	Low
OE7 Possibility to choose advantageous values and methods for quantifying *project* carbon stocks in trees and woody biomass	Unknown	Low to Medium	High
OE8 Net effect of including estimates of long-term carbon storage in harvested wood products	High for commercial afforestation N/A for establishment of natural forest	Low	Medium
OE9 Possible exclusion of leakage accounting if project area grazing is displaced to land capable of supporting higher intensity grazing	Low	Unknown	Medium
Elements likely to contribute to underestimating emission reductions or removals			
UE1 Exclusion of displaced emissions from wood product alternatives	High for commercial afforestation N/A for establishment of natural forest	Low	Low
UE1 Requirement to apply conservative assumptions wherever uncertainty is “significant” associated methodological elements or values used	All	Low	Unknown
UE3 Exclusion of negative leakage	High for commercial afforestation N/A for establishment of natural forest	Low	High

Element	Fraction of projects affected by this element[2]	Average degree of under- or overestimation where element materializes[3]	Variability among projects where element materializes[4]
Elements with unknown impact			
U1 Lack of guidance for how to model baseline scenarios involving active tree planting	Low (based on the assumption that, among projects with significant tree planting in the baseline, few would try to register)	Unknown (difficult to estimate because guidance is lacking)	Medium (there could be varying degrees of baseline planting activity – though presumably within a limited range for truly additional projects)
U2 Use of regeneration monitoring areas to capture possible deviations from baseline scenario assumptions	All	Unknown (not clear how well monitoring areas would work in practice to correct for baseline deviations)	High
U3 Lack of clarity around estimating the *change* in carbon in non-tree vegetation, dead wood, and litter	All	Low (since these typically are not major carbon pools)	Low
U4 Exclusion of soil carbon accounting if site preparation disturbance affects 10% or less of project area	Low	Unknown	Unknown
U5 Standardized approach to determining soil organic carbon increases	Unknown	Low	Medium
U6 Methods to determine leakage emissions	Unknown	Medium	High
U7 Methods for determining carbon emitted from land to which grazing is displaced	Unknown	Unknown	Medium

Table 3 Assessment and qualitative ratings related to carbon stored in harvested wood products

Element	Fraction of projects affected by this element[5]	Average degree of under- or overestimation where element materializes[6]	Variability among projects where element materializes[7]
Elements likely to contribute to overestimating emission reductions or removals			
WP_OE1 Possibility to assume no baseline production of long-term wood products (when in fact there would have been)	Low	Low	Low
WP_OE2 Potential for projects to choose advantageous methods and assumptions for determining volume and types of wood products produced	Unknown	Low	Medium (depends on how much leeway projects have in specifying types of wood products)
WP_OE3 Failure to account for market displacement of other wood production	All commercial afforestation projects	Medium	High
WP_OE4 Required use of 0.5 ratio to determine carbon content of harvested biomass	All commercial afforestation projects	Low (but could be 5-10%)	Low
WP_OE5 Potential for projects to choose advantageous methods for determining amount of carbon stored long-term	Unknown	Low	Low

5 This parameter refers to the likely fraction of individual projects (applying the same methodology) that are affected by this element, considering the potential portfolio of projects. “Low” indicates that the element is estimated to be relevant for less than one third of the projects, “Medium” for one to two thirds of the projects, “High” for more than two third of the projects, and “All” for all of the projects. “Unknown” indicates that no information on the likely fraction of projects affected is available.

6 This parameter refers to the likely average degree / magnitude to which the element contributes to an over- or underestimation of the total emission reductions or removals for those projects for which this element materializes (i.e., the assessment shall not refer to average over- or underestimation resulting from all projects). “Low” indicates an estimated deviation of the calculated emission reductions or removals by less than 10% from the actual (unknown) emission reductions or removals, “Medium” refers to an estimated deviation of 10 to 30%, and high refers to an estimated deviation larger than 30%. “Unknown” indicates that it is likely that the element contributes to an over- or underestimation (e. g. overestimation of emission reductions in case of an omitted project emission source) but that no information is available on the degree / magnitude of over- or underestimation. Where relevant information is available, the degree of over- or underestimation resulting from the element may be expressed through a percentage range.

7 This refers to the variability with respect to the element among those projects for which the element materializes. “Low” means that the variability of the relevant element among the projects is at most ±10% based on a 95% confidence interval. For example, an emission factor may be estimated to vary between values from 18 and 22 among projects, with 20 being the mean value. “Medium” refers to a variability of at most ±30%, and “High” of more than ±30%.

Element	Fraction of projects affected by this element[5]	Average degree of under- or overestimation where element materializes[6]	Variability among projects where element materializes[7]
WP_OE6 Failure to account for ongoing decay in the harvested wood product carbon pool after 100 years	All commercial afforestation projects	Low	Low
Elements likely to contribute to underestimating emission reductions or removals			
WP_UE1 Quantifying only carbon that remains stored after 100 years	All commercial afforestation projects	Medium	High
Elements with unknown impact			
WP_U1 Uncertainties in estimates of carbon that will remain stored in wood products (in-use or in landfills) after 100 years	All commercial afforestation projects	Unknown	Medium

Based on this summary, the methodology is assigned a score of 3 for both commercial afforestation and establishment of natural forest. Overall, there are multiple methodology elements that could result in overestimation of removals from the project activity while only one element was identified to likely lead to underestimation. While the overestimation effects are assessed to likely have a low impact, their combined effect could lead to a moderate degree of overestimation (up to 10%). This corresponds to a score of 3 according to our methodology. The most important overestimation risk may arise from the considerable flexibility that the methodology provides in choosing parameters or approaches (OE3 and OE6). This may lead to significant potential for bad faith "gaming" by project developers that could result in significant overestimation. The potential for this gaming is reduced by the requirement that project developers should use accurate or conservative assumptions and values (Section 3.5 of the methodology). However, the ACR methodology is not as explicit about the application of conservative quantification methods compared to other methodologies. Where the ACR methodology appears superior to other A/R methodologies is in requiring the use of "regeneration monitoring areas," which provide a means to ground-truth baseline carbon stock assumptions. Since uncertainty around baseline carbon is a significant source of uncertainty in quantifying net removals for this project type – especially over longer time periods – requiring these control areas is a useful and important way to improve accuracy. For commercial afforestation projects, the inclusion of wood product carbon introduces further potential for overestimation given the methods prescribed, which could in some instances be significant, depending on harvesting levels. Overall, the quantity of removals may also be associated with considerable uncertainty, noting various elements of uncertainty. The combined uncertainty is assessed to be likely in the range of 10% to 50%. The uncertainty is overall not sufficiently compensated for through conservative assumptions. According to our methodology, this outcome also corresponds to a score of 3.

Annex: Summary of changes from previous assessment sheet versions

The following table describes the main substantive changes implemented in comparison to the assessment from 8 November 2022.

Topic	Rationale
Inclusion of the project type commercial afforestation	The assessment was updated to include the project type commercial afforestation. This includes an assessment to consider the effect of accounting for harvested wood products.
Refinements and changes based on feedback and further information	Based on feedback received and further information, the previous assessment was further refined and changed. This relates to: the inclusion of litter and duff carbon in the project boundary; changes to the assessments of elements U1, U2, OE1, OE2 (previously OE3), OE3 (previously OE4), OE6 (previously OE8); the previous element OE2 was changed to element of uncertainty (U3 in this version); the previous element OE5 was deleted; the conclusions at the end of the document were further refined.