Methodology for measuring net carbon dioxide removal through bioenergy with carbon capture and storage (BECCS)

drax

stockholm exergi

V0.9

October 2023

Prepared by: EcoEngineers

Contents

1 Methodology context

The purpose of this methodology is to show how a project proponent (defined in chapter 2) may quantify its net contribution to climate change mitigation. Such proponents will be using power and/or heat bioenergy with carbon capture and storage (BECCS) as a tool for permanent carbon dioxide removal (CDR). This methodology is built on the principle of conservativeness, calculating the net volume of carbon dioxide (CO_2) removed from the atmosphere through BECCS, and containing measures to avoid overstating removals volumes. In addition, this methodology outlines robust quantification approaches and data sources that can be used to verify net removal volumes and in turn produce CDR credits. It also outlines strict eligibility criteria, such as detailed biomass sustainability requirements.

BECCS technology performs the service of capturing CO_2 and permanently storing it in geological reservoirs. The capture and permanent storage of CO_2 from sustainably sourced biomass delivers permanent negative emissions. This methodology applies to BECCS projects using thermal combustion of solid biomass fuels, i.e. those projects generating CDR credits from energy-generation BECCS plants. It does not apply to other BECCS approaches, such as ethanol-production or waste-to-energy plants – although many of the principles may also be adapted for use with these technologies.

This methodology lays out criteria and approaches that project developers shall adhere to in each step of developing a credit-generating BECCS project. The authors anticipate that it will be updated periodically to reflect the latest approaches and evidence.

The following documents have informed the development of the methodology:

- Intergovernmental Panel on Climate Change (IPCC) Special Report on Carbon dioxide Capture and Storage
- Proposal for an EU Carbon Removals Certification Framework (EU CRC-F), COM (2022) 672 final
- The Integrity Council for Voluntary Carbon Markets – Core Carbon Principles / Assessment Framework (July 2023)
- ISO 14064-2:2019
- ISO 27914:2017
- Puro.Earth – Geologically Removed Carbon
- Gold Standard – Methodology for biomass fermentation with carbon capture and geologic storage – draft for public consultation (2023)

1.1 Version notes

This version of the methodology (v0.9) has been developed by Drax and Stockholm Exergi, with technical inputs from EcoEngineers. It is pending validation by a third party validation and verification body.

The methodology may be revised in future iterations to, inter alia, reflect new best practices or accommodate other project types (e.g. BECCS from the pulp and paper industry), fuel sources or jurisdictions.

2 Project requirements

This chapter lays out the scope of this methodology, as well as the applicability conditions, safeguards and crediting periods that the project proponent is required to follow.

2.1 Methodology scope

The current version of this methodology applies to power and/or heat BECCS projects storing CO_2 in a defined set of jurisdictions. These are: the European Union (EU) and non-EU member states of the European Economic Area (EEA), the United States of America (USA), or the United Kingdom (UK). This jurisdictional limitation is based on said jurisdictions' robust regulations and high enforcement levels, in particular regarding permanent geological sequestration of carbon dioxide. This is not to say that other jurisdictions may not already have equally strong regulatory frameworks; in future iterations, the methodology's scope may be opened to more jurisdictions.

The methodology only applies to forest and agricultural biomass[1], although it may be extended to other forms of biomass in the future. Projects may source biomass from any jurisdiction / source which meets the sustainable biomass criteria outlined in Appendix C.

2.2 Project proponent

The project proponent is defined as the party that has the overall contractual control over, and responsibility for, the BECCS project that generates CDR credits. Typically, this is the operator or owner of the carbon capture system. The project proponent is not required to directly operate all components of the BECCS value chain, and may choose to rely on contractual partnerships for delivery. For example, the project proponent need not be the entity which directly injects or stores the CO_2. The project proponent shall be the sole beneficiary of any carbon credits generated in relation to activities using this methodology.

2.3 Requirements

Applicability conditions

The project proponent shall demonstrate that their project:

a. Uses only sustainable biomass feedstocks, verified appropriately against the conditions laid out in Appendix C of this methodology.

b. Stores captured CO_2 in geological storage only with storage operators that meet local and international applicable regulatory standards for permanent sequestration. Storage sites are to be verified appropriately against the conditions regarding permanence laid out in chapter 8.

[1] Note that Appendix C on sustainable biomass criteria currently only applies to forest biomass. A version of this appendix for agricultural biomass is in development.

c. CO_2 captured through BECCS facilities cannot be used for purposes other than permanent storage, including enhanced hydrocarbon recovery (EHR).[2]

Safeguards

The aim of projects under this methodology is to deliver climate change mitigation through the delivery of CDR. While this delivers a climate benefit, it is important to also consider the social and environmental impact on communities where projects are located. Therefore, at project validation, the project proponent shall demonstrate that their project has:

a. Conducted all relevant stakeholder consultations following the requirements described in Appendix E.

b. Reviewed the full list of safeguards outlined in Appendix F and either i) confirmed they have not identified any project risk of breaching any of these, or ii) provided a mitigation plan for any identified risks. These assessments shall be made available on request to the validation/verification bodies (VVB) engaged to validate the project. If any issues arise against these safeguards during project operation, the project proponent must develop and publish a mitigation plan.

Crediting periods

The project crediting period runs for 15 years and is renewable twice. Each renewal period will require a full review and update of the Project Design Document (PDD – see chapter 9) to ensure continued compliance with all methodology requirements. Renewals will be validated against the latest version of the methodology document, noting that the methodology requirements may be updated over time.

[2] In many cases, BECCS projects are likely to use shared infrastructure for CO_2 transport, injection, or storage with other CO_2 capture projects. Shared infrastructure may also be used for non-applicable activities such as enhanced hydrocarbon recovery (EHR). In the case that a BECCS project uses shared infrastructure where a part of the overall CO_2 is going to EHR, the project developer shall demonstrate that contractually their CO_2 is only intended for applicable non-EHR storage sites. Furthermore, the developer shall provide mass balance evidence from the infrastructure provider that the amount of CO_2 the developer is entitled to was injected in an applicable non-EHR storage site.

3 Project boundaries

The project's boundaries are defined both in terms of spatial extent and in terms of relevant project activities leading to carbon sources and sinks. The boundary is drawn to represent processes that are exclusively initiated by the anticipation of CDR credit revenue from the project. (See Appendix G for a detailed list of emissions included or excluded from the project boundary.)

The spatial extent of the project boundary encompasses:

- The physical, geographical sites where CO_2 associated with bioenergy is captured by the project.
- The sites where the captured CO_2 is processed.
- The sites where the processed CO_2 is compressed and dehydrated.
- The docking sites of the CO_2 transport system.
- The sites where CO_2 is injected for storage.
- The secure underground geological reservoirs where the injected CO_2 is stored.[3]

Furthermore, to ensure a conservative calculation of net removals, this methodology requires the quantification and deduction of both operational supply chain emissions and leakage generated in the BECCS value chain. By subtracting emissions generated along the value chain, this approach ensures that only net removals are credited (elaborated in chapter 7).

3.1 Requirements

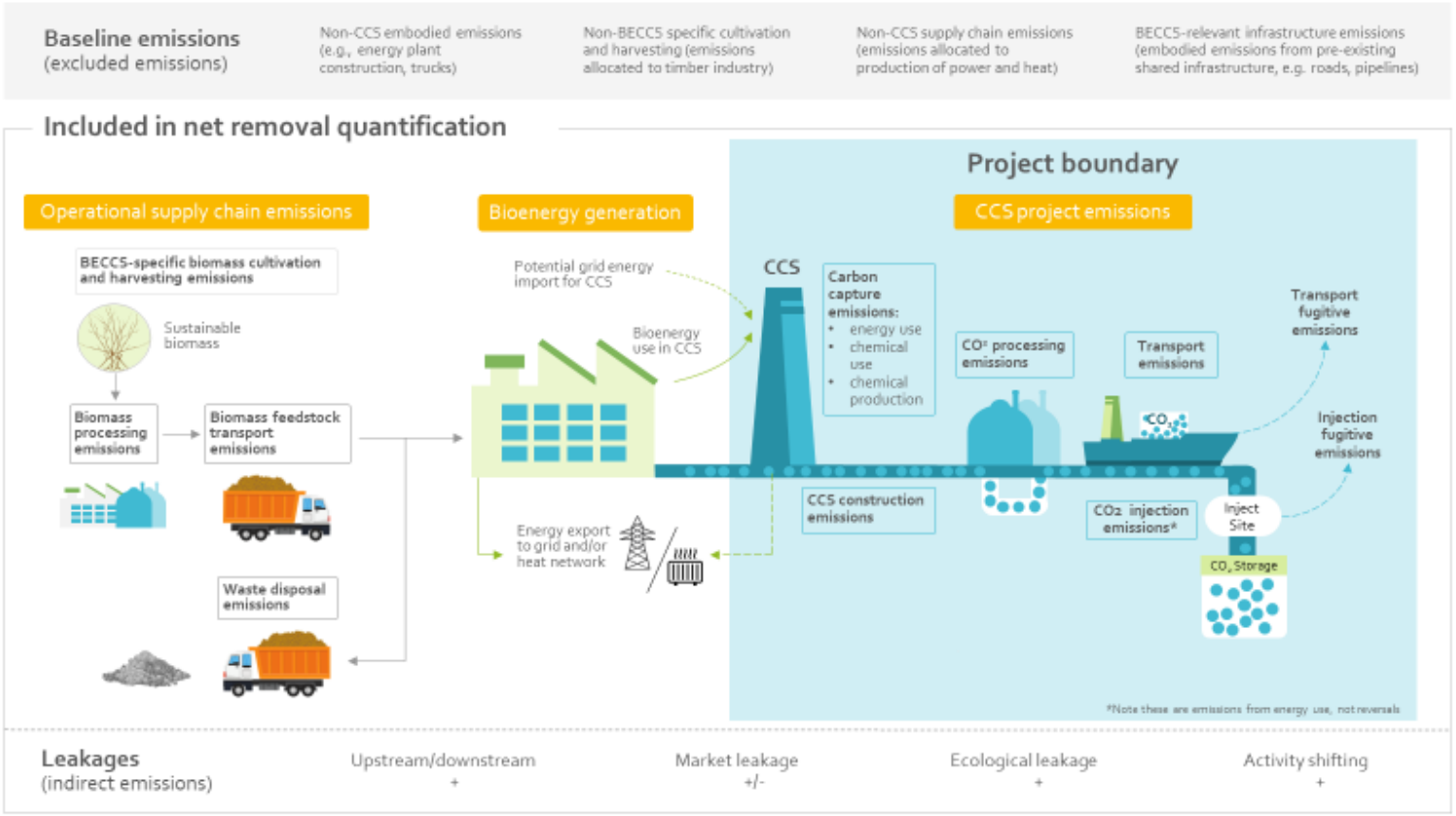
3.1.1 The formal project boundary shall be drawn around the carbon capture, processing, transport and storage components of the BECCS system (see figure 1).

3.1.2 The project proponent must provide the locations of each project site using global positioning system (GPS) coordinates. If pipelines are included in the CO_2 transport process, then the project proponent shall provide a map showing the GPS coordinates for locations along the pipeline.

[3] As adapted from Gold Standard – Methodology for biomass fermentation with carbon capture and geologic storage – draft for public consultation (2023). Note that in cases where projects are connected to complex networks with multiple and evolving CO_2 capture, processing and storage sites, the project boundary would be defined in contractual terms rather than spatial ones for simplicity, for example as the contractual destination of CO_2.

Figure 1 Extent of BECCS project

A BECCS project's boundary encompasses all activities initiated by the anticipation of CDR credit revenues: namely carbon capture, processing, transport, and injection and storage processes. Emissions that would have occurred anyway, absent the BECCS project, are considered baseline emissions, and are excluded from the net removals calculation - as described in chapter 5. For conservativeness, the quantification of net removals accounts for a broader range of activities beyond those strictly within project boundaries: namely operational supply chain emissions and leakages (i.e. indirect emissions), which are deducted from gross CO_2 injected. Note that some market leakages may reduce emissions (e.g. through heat recovery processes on carbon capture units). These concepts are further discussed in chapters 6 and 7.



4 Additionality

Under this methodology, BECCS projects are developed for the purpose of delivering carbon removals. Removals are additional if they would not have taken place without the incentive created by CDR credit revenues. Note that the additionality assessment described in this methodology is designed to follow a 'standardized approach' as defined by the Integrity Council for the Voluntary Carbon Market (ICVCM).

4.1 Requirements

4.1.1 The project proponent shall demonstrate the additionality of their BECCS project by following the approach outlined in figure 2 below:

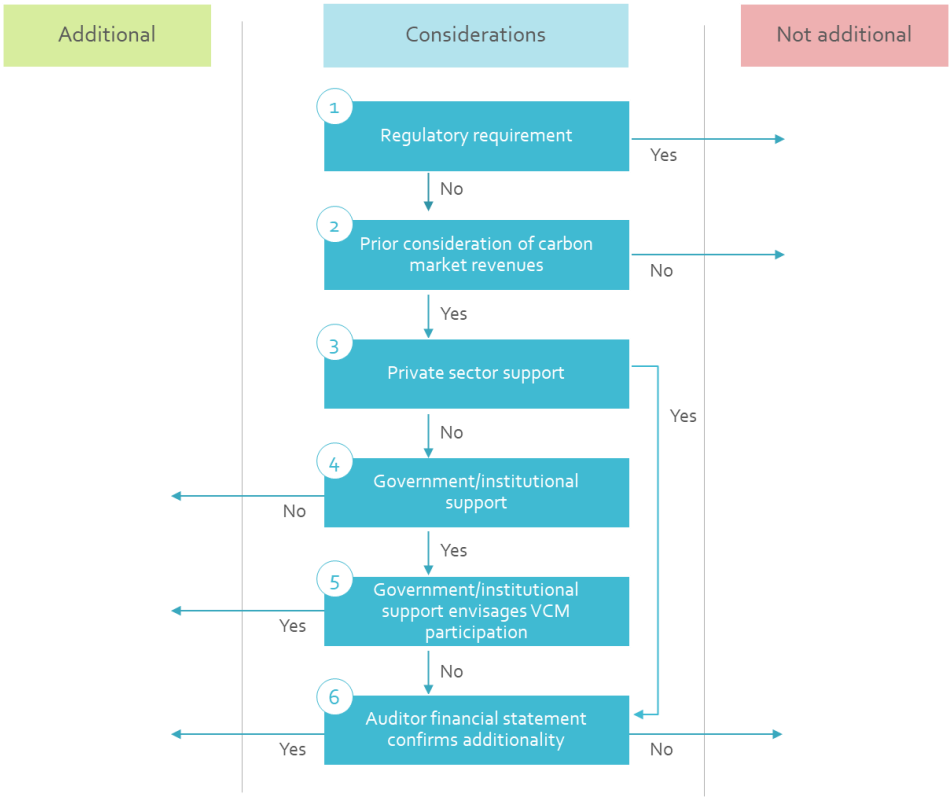


Figure 2 Additionality demonstration diagram

1. **Regulatory requirement:** The project proponent shall demonstrate that there are no existing regulations requiring the proponent to capture and store CO_2 on bioenergy plants within the jurisdiction of the capture unit. Where successfully demonstrated, projects are considered to comply with this requirement for the duration of their crediting period upon validation. This will be

revalidated at each crediting period renewal. If the project is able to demonstrate regulatory additionality, it must move to additionality step 2.

2. **Prior consideration of carbon market revenues:** The project proponent must provide documented evidence (e.g. public announcements, internal decision documents) of 'prior consideration'[4] of carbon market revenues in the decision to develop a project. 'Prior consideration' is defined as reasoning used to justify action or investment in advance of operational commencement. If the project proponent can prove prior consideration, it must move to step 3.
3. **Private sector support:** A project may receive funds from the private sector, other than those from sales of CDR credits or equity funding. Such funding may include grants, prize money and other non-credit related contributions. If this is the case, the project will need to demonstrate additionality using step 6. If the project has no such funds, it must move to step 4.
4. **Government/institutional support:** If a project proponent demonstrates that the project is not in receipt of sources of revenue from governments or public institutions, the project is additional. In cases where there is government / institutional support, the project must move to step 5.
5. **Government support envisages VCM participation:** Government or institutional support may take several forms. Often support is granted with the assumption that the project will participate in the voluntary carbon market (VCM) and therefore that some portion of the project funding will come from the market. If a government envisages that the project will participate in the VCM, the project will be additional, since without the incentive created by CDR credit revenues it would not have received government aid, and therefore would not have taken place. Projects in receipt of government or institutional support that do not envisage VCM participation must move to step 6.
6. **Auditor Financial Statement:** To confirm that projects receiving private sector, government or institutional support would not have taken place absent the incentive of carbon market revenues, a third-party financial auditor will review the finances of activities within the project boundary. The auditor will determine whether said revenues were a necessary factor in the project proponent's decision to initiate the project. If the auditor states that carbon market revenue is necessary, then the project is additional.

[4] ICVCM Core carbon principles, assessment framework and assessment procedure (2023)

5 Baseline determination and quantification

5.1 Defining the baseline

A project baseline describes what would have happened in the absence of a carbon removals project. Under this methodology, the baseline comprises activities in the BECCS process not encompassed in the project boundary. There are two possible baseline scenarios applicable under this methodology:

- Scenario A – retrofit BECCS. The project enables the installing and/or operating of new carbon capture equipment on an existing biomass power and/or heat plant.
- Scenario B – new-build BECCS. The project enables the installing and/or operating of carbon capture equipment on a new biomass power and/or heat plant.

Under this methodology, retrofit refers to the introduction of new materials, products and technologies into an existing bioenergy plant to operate as a carbon capture and storage facility. To qualify as an *existing* biomass power and/or heat plant, it shall have been operational for more than 48 months before the installation of the new materials.

Projects where CCS equipment has been installed on a bioenergy power and/or heat plant less than or equal to 48 months from the operational start date of the plant shall be considered newbuild.

Projects where CCS equipment has been installed on a bioenergy power and/or heat plant more than 48 months from the operational start date of the plant shall be considered retrofit.[5]

Under both scenarios, transport and storage does not necessarily have to be at the capture location, and can be either retrofit or new-build. For both scenarios, the baseline has been designed to be conservative with respect to quantifying net removals. Examples of why the approach is conservative include:

Scenario A – retrofit BECCS:

- A part of operational supply chain emissions is allocated to carbon removals, even though an argument could be made that these emissions would have occurred in any case.
- Energy leakage must be accounted for and subtracted from gross removals, even though the overall system is a net renewable producer.

Scenario B – new-build BECCS:

- The embodied emissions from the construction of the energy plant must be subtracted from net removals, even though an argument could be made for allocating these emissions to energy.

[5] Note that in a scenario in which an energy plant is transformed from using fossil fuels to biomass fuel sources, the decision of whether the BECCS project is new-build or retrofit depends only on the time between the completion of the bioenergy conversion and the completion of CCS installation. For example, a CCS unit that is installed within 48 months of a plant being successfully converted from fossil fuel to biomass usage would be considered a new-build BECCS project, regardless of the time spent on converting the plant.

- Any additional avoided emissions resulting from the renewable energy displacement of more carbon intensive forms of generation is not included in the quantification.

The impact of the different scenarios on quantification is summarized in figure 3 below.

Figure 3 Accounting for construction emissions and energy leakage under retrofit and new-build BECCS

Scenario	Non-CCS bioenergy plant construction in net removals quantification	Energy leakage from capture
Scenario A – retrofit BECCS The project enables the installing and operating of CCS equipment on a biomass power plant which would otherwise continue operations as is	✗	✓
Scenario B – new-build BECCS The project enables the development and operating of a new BECCS plant	✓	✗

5.2 Requirements

5.2.1 Any emissions not attributable to the project shall be categorized as baseline emissions (see description of applicable emissions in Appendix G). These shall not be considered in the net removals calculation (see chapter 7).

5.2.2 At point of project validation, the project proponent shall confirm whether the project shall be considered as a retrofit (Scenario A) or new-build (Scenario B). They should use the definitions in section 5.1 of this methodology.

5.2.3 In either baseline scenario (A or B), if the project developer provides evidence that the underlying biomass power and/or heat plant would generate power / heat even in the absence of CDR generation, a proportion of operational supply chain emissions may be allocated to baseline emissions using an allocation factor (further described in chapter 7).

6 Leakage

BECCS projects may lead to indirect emissions or 'leakage' caused by activities within the BECCS value chain (including biomass production, processing, capture, transport and storage activities). This methodology accounts for all material leakage emissions by subtracting them from gross CO_2 removed.

6.1 Requirements

6.1.1 A project proponent must assess all sources of leakage across four categories of leakage[6], as outlined in table 1 below.

Table 1 Categories of emissions leakage

Source of leakage	Materiality
Upstream/downstream emissions: removals can directly impact emissions that occur downstream or upstream, outside of net removals quantification boundaries. For example, if BECCS was to increase emissions intensity in upstream forestry (e.g. by requiring more emissions intensive equipment) or lead to embodied carbon from the development of non-project specific CO_2 pipeline and storage infrastructure due to the additional demand for such services.	To be assessed through direct quantification of key upstream/downstream emissions sources outside of project boundaries likely to increase due to project activity.
Activity-shifting: shifting emissions to locations not targeted, or emissions not monitored, by the activity. An example is the increase in agricultural emissions from the displacement of agricultural activities from land preferred for biomass production.	Assessed to be non-material due to the stringent biomass sustainability requirements of this methodology. In particular, due to the following protections against land sector leakage: • Biomass feedstock shall not use feedstock suitable for use in long-lived wood products. These sources of fibre are of greatest value and therefore provide the main driver of land use and land management decisions in the forest sector • Biomass feedstock is only sourced from forest areas where the carbon stock is stable or increasing, or where biomass sourcing helps to reverse declines in forest carbon stock (e.g. to mitigate risk of natural disturbance). By assessing carbon stock changes at a jurisdictional or sourcing area

[6] Integrity Council for the Voluntary Carbon market (ICVCM) Core carbon principles, assessment framework and assessment procedure, July 2023

Source of leakage	Materiality
	level, the assessment captures both direct and indirect forest carbon stock changes associated with the project. (See Appendix C)
Market leakage: removals can impact the supply and demand of emissions-intensive products or services. For example, energy leakage would occur if the installation of CCS equipment raises demand for carbon intensive energy.	To be assessed following approach outlined in Appendix D. Note that energy leakage emissions are distinct from direct CCS energy use emissions, which are accounted for in the net removals quantification under CCS project emissions. Energy leakage are indirect emissions that would be caused by changes to the overall grid's emissions intensity resulting from CCS operations. Note: in some cases, there can be negative leakage (i.e. lowering of emissions) – for example through the recovery of process heat replacing other heat production. This benefit may be specified but, due to conservativeness, will only be entered into the net removals calculation when positive leakage occurs, i.e. increase in emissions due to leakage.
Ecological leakage: a removals project can have an indirect impact on emissions from hydrologically-connected areas. An example would be carbon dioxide emissions from soils in a wetland if the water level is lowered following increases in water demand from biomass feedstocks grown on land that is hydrologically- connected to the wetland.	Materiality to be assessed through an environmental impact assessment.

6.1.2 For **upstream/downstream emissions leakage** and **ecological leakage,** the project proponent shall include the following steps:

a) List sources of potentially relevant emissions and quantification estimates for these.

b) Identify those sources of emissions most likely to increase in response to BECCS deployment, with an estimated potential impact (expressed as the % increase of emissions from these sources, relative to baseline level).

c) Quantify any emissions sources estimated to potentially have material impact (>2% of gross injected CO_2) using a life cycle analysis (LCA) approach and add the value to the leakage calculation in the quantification chapter.

6.1.3 To ensure no activity-shifting leakage, including land sector leakage, the project proponent shall meet all sustainable biomass criteria laid out in Appendix C.

6.1.4 To quantify energy leakage, a component of market leakage, the project proponent shall follow the process outlined in Appendix D.

7 GHG removal quantification

This chapter details the method that the project proponent must follow to quantify the number of CDR credits they can receive from removing greenhouse gases (GHGs) through BECCS activity. This number is determined by the amount of CO_2 that has been permanently removed and stored through the BECCS project, minus all direct emissions associated with CCS operation and supply chain emissions, and minus indirect emissions from leakage.

Any emissions will be converted to CO_2e using the most recently available IPCC criteria.[7]

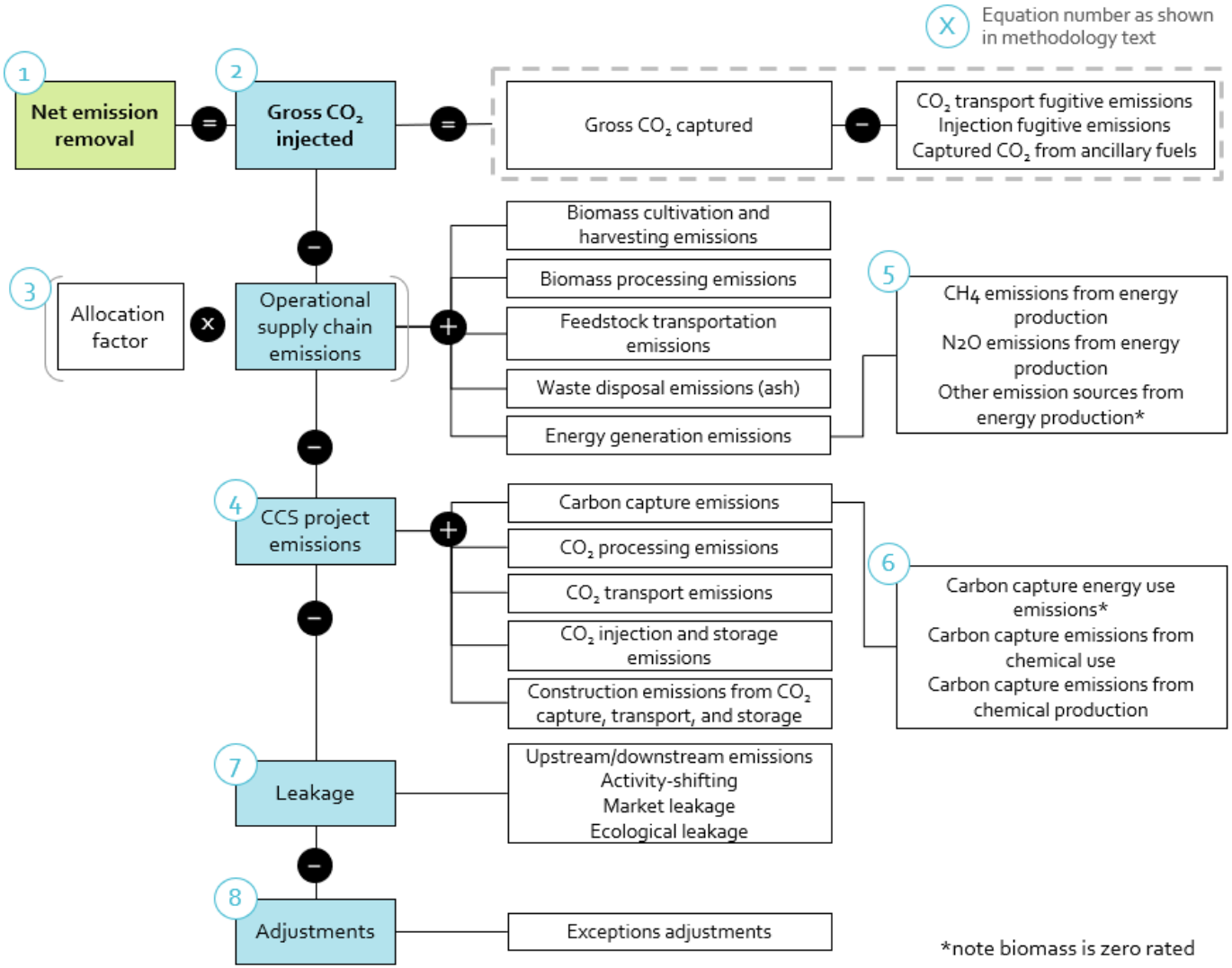
7.1 Requirements

7.1.1 The project proponent shall measure total CDR credits generated by BECCS using the approach outlined in figure 3 below and the subsections and equations that follow. These equations have been designed to capture a conservative estimate of the 'net' volume of removals produced by a BECCS project.

7.1.2 The full quantification shall be carried out at validation and applied at each subsequent verification and credit issuance. Not all variables need to be updated at each quantification - certain variables only need updating annually (with updates required for each calendar year after validation). Each data/parameter shall be monitored according to the frequency outlined in the sampling plan noted in the PDD (an example is shown in chapter 9).

[7] See IPCC Sixth Assessment Report, 2021, Chapter 7. available at: https://www.ipcc.ch/report/ar6/wg1/downloads/report/IPCC_AR6_WGI_Chapter_07_Supplementary_Material.pdf

Figure 4 Removal quantification



Net removals

(eq 1) $$NCR_y = GICR_y - OSC_y - PE_y - L_y - A_y$$

Where:

NCR_y	Total net CO_2 removed in period Y	tonnes of CO_2e
$GICR_y$	Gross injected CO_2 removals in period Y	tonnes of CO_2
OSC_y	Operational supply chain emissions in period Y	tonnes of CO_2e
PE_y	Total project emissions in period Y (see equation 3)	tonnes of CO_2e
L_y	Leakage emissions in period Y	tonnes of CO_2e
A_y	Adjustments in period Y	tonnes of CO_2e

Gross injected CO2 removals

The preferred approach for quantifying injected CO_2 removal volumes is through documentation from the storage operator that certifies the gross volumes of injected CO_2 attributed to the BECCS project. If certification showing injected CO_2 volumes directly attributable to the BECCS project is provided, this figure shall be used directly,[8] and fugitive emissions need not be estimated.

Where certification is not available (e.g. if a storage operator is unexpectedly unable to verify CO_2 allocations from multiple CCS plants that may be feeding into a single injection site), then equation 2 shall be used to estimate gross injected removal volumes. Equation 2 relies on metering data from the capture facility for calculating carbon removals, not on data from the point of injection.

(eq 2) $$GICR_y = GCC_y - TFE_y - IFE_y - AFC_y$$

Where:

$GICR_y$	Gross injected CO_2 in period Y (monitoring table 1)	tonnes of CO_2
GCC_y	Gross captured CO_2 in period Y (monitoring table 2)	tonnes of CO_2
TFE_y	CO_2 transport fugitive emissions in period Y (monitoring table 3)	tonnes of CO_2
IFE_y	Injection fugitive emissions in period Y (monitoring table 4)	tonnes of CO_2
AFC_y	Carbon captured and stored originating from ancillary fuels used in period Y (monitoring table 19)	tonnes of CO_2

[8] Note: in some cases, the project proponent may wish to use a proportion of the gross injected removal volumes for other mitigation reporting uses. Where this is the case, the project proponent shall provide evidence to the VVB of the volume of removals being used for these different purposes, and these volumes shall be subtracted from gross injected removals prior to the rest of the calculation.

Project developers shall make transparent in their PDD an estimation of fugitive emissions from carbon transport and injection processes. They should also estimate the uncaptured emissions from the burning of ancillary fossil fuels (e.g. for starting up the biomass combustion process or use in regenerative thermal oxidisers). Developers should review these estimates in their annual reporting to ensure fugitive emissions are not underestimated.

Operational supply chain emissions

Operational supply chain emissions include all emissions related to the supply of biomass feedstock used for BECCS, which is the sum of:

- Biomass cultivation and harvesting emissions
- Processing emissions (for example, processing woody biomass into pellets)
- Transport emissions from moving feedstock (the project proponent will need to acquire and hold data on all transportation methods, their emissions factors, and the distances travelled)
- Emissions from removing and transporting the waste generated through bioenergy or carbon capture activities (for example, removing ash).

For biomass cultivation and harvesting emissions, note that only those emissions directly attributable to the cultivation and harvesting of biomass for BECCS purposes (e.g., collection of residues) shall be included in this quantification – all other emissions shall be excluded as these should be allocated to the timber operator.[9] The emissions associated with the collection, transport, and processing of the feedstock for BECCS shall, however, be included in the quantification.

Operational supply chain emissions will also include emissions from energy generated onsite. Note that the sustainable biomass criteria of this methodology, particularly those on sourcing from stable or increasing forest carbon stocks, ensure that BECCS operations shall not cause emissions from direct land use changes.

(eq 3) $$OSC_y = AF_y \times (BCHE_y + BPE_y + TFS_y + WEy + GCE_y)$$

Where:

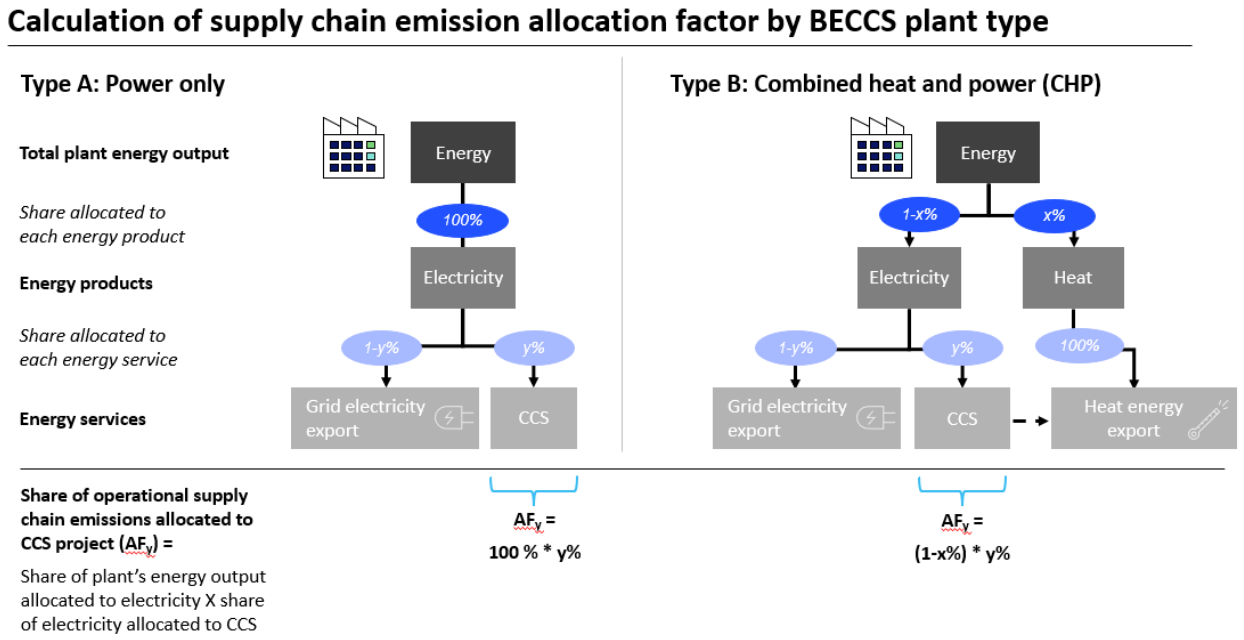
OSC_y	Operational supply chain CO_2 emissions in period Y	tonnes of CO_2e
AF_y	Proportion of emissions allocated to net CO_2 removed in period Y (monitoring table 21)	%
$BCHE_y$	Biomass cultivation and harvesting emissions in period Y (monitoring table 5)	tonnes of CO_2e
BPE_y	Biomass processing emissions in period Y (monitoring table 6)	tonnes of CO_2e
TFS_y	Biomass feedstock transportation emissions in period Y (monitoring table 8)	tonnes of CO_2e

9 If, for example, biomass for BECCS is sourced from forest residues from growth for high-value wood products, then emissions from biomass cultivation shall not be allocated to the BECCS project as they are already allocated to the timber operator through high-value wood products.

WE_y	Waste disposal emissions in period Y (monitoring table 7)	tonnes of CO_2e
GCE_y	Energy generation emissions in period Y (see equation 4)	tonnes of CO_2e

Operational supply chain emissions can either be fully allocated to carbon removals or be partially allocated against different energy products that may be produced through the bioenergy generation process. The use of the allocation factor is left to the discretion of the project proponent. If project proponents wish to partially allocate operational supply chain emissions to other products (e.g. heat and electricity), the split of emissions between these products shall be conducted in accordance with the GHGP standard[10] for the Allocation of GHG Emissions. For example, operational supply chain emissions can be allocated to all "products" indicated as arrows in the below diagram:

Figure 5 Allocation of emissions to heat and electricity



Project proponents shall calculate the allocation factor (AF_y), i.e. the share of operational supply chain emissions allocated to the CCS product, by multiplying the share of electricity production within the plant's total energy output (including electricity and heat) with the share of electricity used in CCS activities. Operational supply chain emissions may be 'allocated' to different products according to this ratio of energy output. To the extent operational supply chain emissions are not being applied to energy products, those emissions shall be fully allocated to the carbon removal product. For avoidance of doubt, all emissions associated with the electricity used for CO_2 capture and transportation preparation (i.e.

[10] GHG Protocol - Allocation of GHG emissions from a combined heat and power (CHP) plant, Guide to calculation worksheets (2017)

electricity required for carbon capture, liquefaction and interim storage) shall be fully allocated to the carbon removal product. In order to apply a conservative approach, none of the operational supply chain emissions will be allocated to any potential heat product based on heat recovery from the carbon capture, the liquefaction or the interim storage.

Project emissions from energy production

Emissions from energy production will not include CO_2 emissions from the combustion of sustainable biomass due to their 'zero rated' nature (as detailed in Appendix A and Appendix C). However, combustion of biomass typically results in the production of CH_4 and N_2O, which shall be taken into account. This may also include emissions from managing any waste streams from the energy production activities.

(eq 4) $$GCE_y = TCH4_y + TN2O_y + OES_y$$

Where:

GCE_y	Emissions from energy generation in period Y	tonnes of CO_2e
$TCH4_y$	Total CH_4 emissions from energy production in period Y (monitoring table 9)	tonnes of CO_2e
$TN2O_y$	Total N_2O emissions from energy production in period Y (monitoring table 10)	tonnes of CO_2e
OES_y	Other emission sources from energy production in period Y (monitoring table 11)	tonnes of CO_2e

Total project emissions

The quantification shall subtract all emissions generated from the construction and operation of CCS equipment. This includes all emissions regarding the installation and operation of carbon capture processes, and involves:

- Emissions from the operation of the carbon capture process, including chemical use and production, and energy use.
- Emissions for processing captured carbon (including liquefaction).
- Emissions from transport of CO_2 to injection and storge sites following the capture process (the project proponent will need to acquire and hold data on all transportation methods, their emissions factors, and the distances travelled).
- Emissions generated from injection and storage processes (including from any energy used in pumping and maintaining the CO_2 in its storage location).

- Emissions from installing or building the carbon capture units, and in the case of new-build BECCS, emissions from the construction of the bioenergy power and/or heat plant.[11]

Any construction emissions directly attributable to the project (e.g. installation of CCS equipment or bioenergy plant construction emissions for new-build) shall be identified, included and amortised over 15 years. This reflects the duration of one crediting period as described under clause 2.3.3 above. Once all embodied emissions have been amortized over the first crediting period, they shall not be included as project emissions in future periods.

(eq 5) $$PEy = PEC_y + PEP_y + PET_y + PES_y + EEI_y$$

Where:

PE_y	Total project emissions in period Y	tonnes of CO_2e
PEC_y	Project emissions from capture in period Y (see equation 6)	tonnes of CO_2e
PEP_y	Project emissions from CO_2 processing, compression and dehydration in period Y (monitoring table 15)	tonnes of CO2e
PET_y	Project emissions from CO_2 transport in period Y (monitoring table 16)	tonnes of CO_2e
PES_y	Project emissions from CO_2 injection and storage in period Y (monitoring table 17)	tonnes of CO_2e
EEI_y	Embodied CO_2 emissions from construction and installation in period Y (of carbon capture equipment embodied emissions in the case of retrofits, and including energy plant and BECCS-relevant infrastructure embodied emissions for new-builds) (monitoring table 18)	tonnes of CO_2e

Project emissions from capture

In most cases, the energy required to operate CCS equipment will come through the biomass energy generation process. Any energy used for CCS from on-site biomass generation will not need to be subtracted from gross removals as all relevant emissions are factored into the supply chain emission and project emissions from energy production calculations. Potential secondary effects on the grid – for example, energy leakage – are considered further in equation 7 and Appendix D.

In some cases, however, the carbon capture process may be powered by energy purchased from third party sources. In these cases, the carbon emissions from energy can be determined by multiplying the energy used to operate the CCS equipment by the most locally available grid emissions factor. In cases where the CCS equipment is operated using a dedicated generation facility, with energy provided directly

[11] This will also include the embodied emissions from any construction activity for transport, injection, or storage directly caused as a result of the BECCS project, for example CO_2 pipelines or storage sites. Only construction activity for transport, injection, and storage infrastructure occurring as a direct result of the BECCS project shall be counted as embodied emissions in this calculation. Any indirect impacts, for example increased demand for shared CO_2 storage sites, will be accounted for under the upstream/downstream leakage calculations as described in chapter 6.

to the CCS facility (e.g. by direct wire, or PPAs fulfilling strict temporal and geographical constraints[12]), then an emission factor specific to the carbon intensity of the generation facility may be used. Energy attribute certificates (EACs) shall not be used for conferring the carbon intensity of energy used by the plant.[13]

Chemicals produced for use in the carbon capture process shall also have their upstream emissions quantified using supply chain-relevant and chemical-specific emissions factors. Chemicals used in the carbon capture process are also likely to contain embodied emissions that are then released through the CO_2 capture process. These emissions shall also be quantified using chemical-specific emissions factors (which shall be defined in the PDD and revised periodically during full verification). In addition, some methods may release other GHGs due to chemical use, and these shall also be quantified with chemical-specific emissions factors.

(eq 6) $$PEC_y = CCE_y + CCCP_y + CCCU_y$$

PEC_y	Project emissions from capture in period Y	tonnes of CO_2e
CCE_y	Carbon capture energy use emissions in period Y (monitoring table 12)	tonnes of CO_2e
$CCCP_y$	Carbon capture emissions from production of chemicals used in capture processes in period Y (monitoring table 14)	tonnes of CO_2e
$CCCU_y$	Carbon capture emissions from chemicals use in capture processes in period Y (monitoring table 13)	tonnes of CO_2e

Leakage

As discussed above, all material leakages shall be considered in the calculation of net emissions removals. Leakages should be assessed against the four main leakage types introduced above, and those with leakage values higher than a materiality threshold of >2% of gross captured emissions (GCE_y) shall be subtracted from gross injected emissions (GIE_y). Leakages shall be assessed using the framework described in chapter 6 and summed up as in the equation below. See also Appendix D for further details on estimation approaches for energy leakages, considered as a sub-set of the market leakage category below.

(eq 7) $$L_y = UDE_y + ASE_y + MLE_y + ELE_y$$

L_y	Emissions from leakage in period Y	tonnes of CO_2e
UDE_y	Emissions from upstream/downstream leakages in period Y	tonnes of CO_2e
ASE_y	Emissions from activity shifting leakages in period Y	tonnes of CO_2e

[12] Such as those proposed in the EU delegated act on renewable liquid fuels: https://energy.ec.europa.eu/system/files/2023-02/C_2023_1087_1_EN_ACT_part1_v8.pdf

[13] Note that regardless of the emissions associated with any energy 'drawn-down' from the grid, energy leakage risks shall continue to be assessed as described in equation 7 and Appendix D. In the case where renewable energy is drawn from the grid to power a CCS process, energy leakage remains. Energy has been removed from grid capacity, and so this capacity would need to be replaced to fill demand.

MLE_y	Emissions from market leakages in period Y	tonnes of CO_2e
ELE_y	Emissions from ecological leakages in period Y	tonnes of CO_2e

Adjustments

Exception adjustments allow for reductions to the number of credits that may be issued in a given period. In the case where a project proponent fails to meet particular requirements within this methodology, (e.g. the failure of certain biomass consignments against the sustainability criteria in Appendix C), the project proponent, VVB, and registry may propose conservative compensation mechanisms. Exact agreement on these compensation adjustments will require adoption by the VVB and registry. Such exceptions shall be quantified and verified by the VVB against the terms of the methodology.

Additional subtraction adjustments to gross removals may be added at the discretion of the project proponent.

8 Storage and permanence

For CDR activities to have sustained impact on lowering atmospheric carbon, and so for carbon credits to be issued, storage of captured CO_2 must be permanent with a risk of reversal scientifically determined to be negligible. This chapter outlines requirements for all storage operators used by a BECCS project, to ensure that CO_2 is stored permanently, and with transparent reporting in place.

8.1 Scientific and regulatory basis for permanent storage of carbon

Subject to the requirements contained in this methodology, CO_2 may be considered permanently stored from the point of injection into its geological reservoir given the negligible risk of reversal.[14] This level of permanence risk has been assessed based on robust scientific evidence and regulatory conditions.

Scientific risk of reversal

- The IPCC special report on carbon dioxide capture and storage[15] states that: 'For large-scale operational CO_2 storage projects, assuming that sites are well selected, designed, operated and appropriately monitored, the balance of available evidence suggests the following: It is very likely the fraction of stored CO_2 retained is more than 99% over the first 100 years; It is likely the fraction of stored CO_2 retained is more than 99% over the first 1000 years.'
- Similarly, the containment certainty study regarding 'Deep Geological Storage of CO_2 on the UK Continental Shelf'[16] confidently concluded that less than 0.01% of injected CO_2 is likely to escape into the atmosphere for typical UK offshore sites with permitted storage complexes after 25 years of injection and 100 years of storage[17]. The study was based on a review of close to 100 studies and analysis of failure data from a global database of well equipment reliability.

Regulatory conditions

- As per the applicability criteria, the methodology applies only to sequestration occurring in the Member States of the European Union, non-EU Member States of the European Economic Area (EEA), the UK, and the USA. These jurisdictions require having a permit that guarantees safe and permanent storage of carbon through appropriate site selection and characterization and the adoption of safe injection and storage methods. These regulations require storage operators to monitor stored carbon during and post injection, as well as after site closure, to ensure that leaks do not occur. In addition, storage operators must report monitoring results at least once a year in the EEA and UK, and semi-annually in the USA.

[14] Reversal refers to any migration of carbon dioxide from its geological reservoirs post injection. This is also sometimes known as 'leakage', so to avoid confusion with the notion of indirect emissions, this document only uses the term 'reversal'.

[15] IPCC special report on carbon dioxide capture and storage – Chapter 5 Underground geological storage, p.246, 2005

[16] BEIS Deep Geological Storage of CO_2 on the UK Continental Shelf - Containment Certainty, p.9, 2023

[17] Probability across 125 years

- In these jurisdictions, permanence is further strengthened by the transfer of responsibilities to government following site closure. In the EEA and the UK, once all evidence demonstrates that stored carbon will be completely and permanently contained, operational and financial obligations pertaining to storage site maintenance, monitoring and implementation of corrective measures are transferred from the operator to the relevant competent authority. In the USA, transfer provisions are defined at the state level. As an example, in Louisiana[18], ownership of the storage facility is transferred to the state by default 50 years after the end of injection operations if carbon sequestration is shown to be safe and permanent.
- In the event of emissions released from the storage site, the storage operator will be required to take different mitigation measures depending on local regulations. These regulations, including the risk of having the license revoked, create strong incentives for the storage operator to operate the site in line with industry standards. For example:
    - If carbon dioxide stored migrates from its geological reservoir to the atmosphere, storage operators in the EEA must surrender ETS emissions allowances (EUA). A similar approach exists in the UK. This ensures that net emissions in the system do not change as a result of the project.
    - In the USA, remediation mechanisms are defined at the federal and state levels. At the federal level, EPA Class VI rules do not target emissions from leaks specifically but require storage operators to have an emergency remediation plan and to take corrective action to prevent dangerous movements of carbon underground. Storage operators may also lose access to government subsidies if carbon is not stored permanently. For example, benefits from USA's tax credit on carbon sequestration 45Q[19] will be 'recaptured' if the carbon ceases to be 'disposed of in secure geological storage'.

In future, this methodology may be extended to jurisdictions other than the EU, non-EU member states of the EEA, UK and USA if the project proponent can provide evidence that relevant local regulations meet or exceed the requirements set out in the ISO 27914:2017 standard on Carbon Dioxide Capture, Transportation and Geological Storage.

8.2 Requirements

In addition to adhering to relevant local regulations on the storage of CO_2, the relevant party responsible for transport and storage of carbon shall provide evidence to the project proponent that they have carried out the below requirements:

8.2.1 Provide certificates of CO_2 injection attributable to the project proponent to inform the net removal quantification described in chapter 7.

8.2.2 Store CO_2 in geological storage sites within the list of jurisdictions detailed in Appendix B.

[18] Louisiana Geologic Sequestration of Carbon Dioxide act 2009

[19] US Code 45Q – credit for carbon oxide sequestration 2008

8.2.3 Conduct a risk assessment prior to project implementation and produce a plan for monitoring reversals if this is not already required by relevant local regulations.

8.2.4 Adhere to ISO 9001 or 14033 or equivalent standard of procedure in relation to the management of data.

Following these requirements, the relevant party will fulfil the permanence materiality assessment defined by criteria 9.1 c) in the ICVCM core carbon principles assessment framework.[20] ICVCM criteria 9.1 and 9.3 note that financial mechanisms to account for reversal risks, such as pooled buffer reserve or insurance, will not be required for projects with non-material risks of reversals. ICVCM notes that CCS projects with geological storage are likely to have non-material risk of reversal, and so unlikely to require financial mechanisms for mitigating reversal risks.

[20] ICVCM Core carbon principles, assessment framework and assessment procedure (2023)

9 Reporting, validation and verification

This chapter explains the reporting, validation and verification processes for BECCS projects. Reporting is defined as the submission of data and evidence to a third-party organisation (a VVB) for the purpose of independently assuring project outcomes. Validation is defined as the confirmation of a project's adherence to all requirements in this methodology. Project validation also signifies the beginning of the crediting period. Verification is defined as the assurance of claims of net CO_2 removal volumes that inform each credit issuance, following the quantification approach shown in chapter 7.

9.1 Outline of reporting, validation and verification processes

As described in 9.2, the project proponent is required to develop a Project Design Document (PDD) to describe all relevant technical components of a BECCS project. This PDD will be a 'living document' that will change over the life of the project.

The project proponent may choose to validate their PDD before commencing any further project activity, such as the construction or installation of any carbon capture assets. PDD validation can give confidence that, should BECCS projects be developed according to the specifications of the PDD, their operations will be compliant with the requirements of this methodology. The PDD validation also gives the project proponent an opportunity to confirm additionality before construction.[21]

A project proponent shall develop a monitoring plan within the PDD that describes how a project can provide evidence of compliance with all validation and verification requirements in this methodology. An independent VVB shall review this monitoring plan during PDD validation (or project validation, if PDD validation is not sought). The VVB may suggest edits to the reporting frequency of specific variables according to their best judgement on what is needed to determine high integrity BECCS removals. An indicative monitoring plan is shown in Annex J.

An illustrative project timeline is shown in the table below, with validation and verification requirements for each stage shown in the appropriate column. Cells highlighted in blue represent formal reporting requirements as part of this methodology. Cells in white are included for information only, to describe how the project reporting processes may align with a typical BECCS project. Note: unless specifically detailed in the table below, VVBs will be required to assess data that the project proponent shares with them. Where more stringent validation or verification approaches are required (e.g. VVB site visits), these are noted in the table.

[21] Even if additionality is confirmed before the start of the project crediting period, this confirmation of additionality will apply for the full duration of the first crediting period once it begins.

Stage	Event or process	Likely reporting frequency	Requirements
Project development	Front-end engineering design (FEED)	Once.	Technical plans for carbon capture, processing, transport and storage components of the BECCS system.
	Project Design Document (PDD)	Once, but updated periodically during project validation and full verification events.	The PDD compiles all relevant project data that reflects the project proponent's plan for adherence to the methodology. The PDD shall include: • Name of project proponent; name of carbon capture operator; name of transport operator; name of storage operator and key contacts for project operation and crediting. • Plan for project implementation (start date, timeline, expected project duration). • Description of value chain and technologies. • Project boundaries. • Projected GHG emissions and removals by GHG source, sink and reservoir for the project and baseline emissions. • Description of methods used in calculating projected GHG emissions and removals. • Description of baseline. • Disclosure of all areas of uncertainty and quality control methods for each requirement • Monitoring plan, which outlines the nature, timing and frequency of validation and verification activities, including all the data points that need to be reported (as listed in Appendix I). This shall also include sampling requirements for site visits to biomass sourcing, carbon capture, and injection and storage sites, as required for project validation. • Proof of additionality. • Proof of biomass sustainability. • Confirmation of compliance with storage and permanence requirements. • Stakeholder consultation plan. • Sustainable safeguards or mitigation plan.
	PDD validation (optional)	Once, likely before a project final investment decision (FID) is confirmed.	VVB to review PDD against all BECCS methodology requirements. VVBs shall: • Assess and confirm project additionality (see chapter 4). • Assess alignment of biomass sourcing policy with sustainable biomass sourcing requirements in Appendix C.

Stage	Event or process	Likely reporting frequency	Requirements
			• Assess alignment on plans for CO_2 storage and permanence with requirements (see chapter 8). • Review and edit project monitoring plan (see Appendix J). • Review project boundary definition (see chapter 3). • Assess sources of leakage for materiality (see chapter 6). • Estimate projected gross and net CO_2 removal volumes over lifetime of project (see chapter 7). • Define the targeted baseline scenario definition (retrofit or new build - see chapter 5). • Validate that safeguard risks (as detailed in Appendix F) have been assessed and mitigation plans developed where necessary. • Confirm the applicability of VVB credentials against the requirements of clause 9.2.13.
	Final Investment Decision (FID)		Commercial decision on beginning project construction phase.
	Construction phase		Construction of project.
	Operational commencement ("Project start")		This should be logged in the PDD.
Crediting period 1 (15 years)	Project validation	Once, likely at point of first verification after operational commencement. Note it is likely that project validation will coincide with first credit issuance.	VVB to validate that the completed and operational BECCS project meets all methodology criteria based on the most recently updated version of the PDD, thus beginning the project crediting period. VVBs shall: • Assess and confirm additionality – although this is not required if additionality has already been confirmed in PDD validation. • Assess alignment of biomass sourcing sites with sustainable biomass sourcing requirements in Appendix C. This will require the VVB to conduct site visits to a sample of biomass sourcing areas as considered proportionate in the monitoring plan. • Assess carbon capture site alignment with methodology requirements in chapter 2. This will require the VVB to conduct site visits to a sample of carbon capture sites as considered proportionate in the monitoring plan.

Stage	Event or process	Likely reporting frequency	Requirements
			• Assess alignment of injection and storage sites with requirements shown in chapter 8. This will require the VVB to conduct site visits to a sample of injection and storage sites, as considered proportionate in the monitoring plan. • Confirm that project boundaries are accurate and relevant (as described in chapter 3). • Assess the accuracy of all parameters required to complete the net removal. quantification (see chapter 7). Assess that all parameters meet the quality assurance standards described in the monitoring tables in Appendix I. Assess that all metrics have been quantified within the reasonable materiality threshold (see clause 9.2.15). • Review materiality assessments for leakages (see chapter 6) to ensure they are accurate, and review the accuracy of any leakage required to be quantified and subtracted from the net removal quantification. • Confirm baseline definition of retrofit or new build (see chapter 5). • Validate that safeguard risks as detailed in Appendix F have been assessed and mitigation plans developed where necessary. • List any deviations from PDD validation (if applicable). • Confirm the applicability of VVB credentials against the requirements of clause 9.2.13.
	Streamlined verifications for credit issuances	Submitted at each point of credit issuance. Frequency may be monthly, quarterly, or semi-annual – left to the discretion of each project.	VVBs shall verify the accuracy of data informing the net removals calculation as described in chapter 7, including documentation from the storage operator certifying the gross volumes of CO_2 injected. Variables shall be updated as described in the PDD, and follow the quality assurance measures as defined in the monitoring tables in Appendix I. VVBs shall also confirm the applicability of their credentials against the requirements of clause 9.2.13.
	Full verification reports	Annual, at least once per calendar year after the year of project validation. The VVB may require a full verification where there have been significant changes to project approach or emissions.	As with streamlined verifications, VVBs shall verify the accuracy of data informing the net removals calculation as described in chapter 7. In the full verification report, the project proponent shall update all parameters required for the calculation, including those not measured constantly through the project's operation. VVBs shall assess these parameter updates for their likely accuracy over the 12-month period to the next full verification. VVBs shall also verify that the BECCS project continues to meet methodology criteria. VVBs shall:

Stage	Event or process	Likely reporting frequency	Requirements
			• Assess alignment of biomass sourcing sites with sustainable biomass sourcing requirements in Appendix C. • Assess carbon capture site alignment with methodology requirements in chapter 2. • Assess alignment of injection and storage sites with requirements in chapter 8. • Confirm that project boundaries are accurate and relevant (as described in chapter 3). • Review materiality assessments for leakages (see chapter 6) to ensure they are accurate, and review the accuracy of any leakage required to be quantified and subtracted from the net removal quantification. • Validate that safeguard risks as detailed in Appendix F have been assessed, that risk assessments continue to be applicable, and that mitigation plans have been developed where necessary. • Confirm the applicability of VVB credentials against the requirements of clause 9.2.13.
Crediting periods 2 and 3 (15 years each)	Validation renewal[22]	At end of 15-year crediting period (can renew up to 2 times).	Verify that project continues to meet all methodology criteria – with requirements as above for project validation.
	Streamlined verifications for credit issuances	As above for crediting period 1.	As above for crediting period 1.
	Full verification reports	As above for crediting period 1.	As above for crediting period 1.

[22] Validation for subsequent crediting periods likely to commence before the end of the preceding crediting period to ensure smooth transition.

9.2 Requirements

Project Design Document

9.2.1 All relevant project data shall be compiled in the form of a Project Design Document (PDD). The PDD will reflect the project proponent's plan for adherence to this methodology. As a minimum, the PDD shall include the following:

a. Key contacts responsible for the project operation and crediting, including names, titles, and contact information.

b. Name(s) of carbon capture, transport, and storage operator(s).

c. Name of project proponent.

d. A plan for project implementation including:

   1) A project start date.

   2) Timeline or chronology for the project.

   3) Expected project duration.

e. Description of value chain and technologies applied in the value chain.

f. Spatial, visual and written depictions of project boundaries, process flows, and metering.

g. List of all GHG sources, sinks and reservoirs (SSRs) controlled and affected by, and related to, the project – with criteria for their inclusion in quantification.

h. A description of the projected aggregate GHG emissions and removals by GHG SSR for the GHG project and baseline (stated in units of CO_2e) for the relevant period (e.g. annual, cumulative to date, total), and reflecting the principle that removals are not overstated.

i. General description of criteria, procedures or guidance used in calculating GHG emissions and removals.

j. Description of baseline (including allocation factor where appropriate).

k. Disclosure of all likely areas of uncertainty. This may include any lapses in feedstock documentation, data irregularities, scientific uncertainty in land use, land-use change and forestry (LULUCF) modelling for applicable regions, geological uncertainty involving formations or CO_2 plume modelling, and LCA considerations where subjective decisions were made regarding boundaries and exclusions of SSRs.

l. Quality control methods for each requirement (see row 'QA/QC procedures to be applied' in the monitoring tables in Appendix I on managing data).

m. Defined frequency of project monitoring and reporting (see Appendix J for further details about the monitoring plan).

n. Timing/frequency of validation and verification activities.

o. Proof of additionality.

p. Proof of biomass sustainability, as described in Appendix C.

q. Confirmation of storage operator compliance with the storage and permanence requirements detailed in chapter 8 of this methodology.

r. Stakeholder consultation plan.

s. Confirmation that project risk of breaching sustainable safeguards is absent, or mitigation plan for identified risks is in place.

9.2.2 In the PDD, the project proponent shall develop a monitoring plan that will be used for all project validation and verification reports. This monitoring plan will outline the frequency for collecting, reporting on, and independently verifying data points. Monitoring plans shall show how the project proponent plans to provide data for all variables shown in the monitoring tables in Appendix I.

9.2.3 The monitoring plan shall be reviewed by the VVB during PDD validation (or project validation if no PDD validation is sought). The VVB shall use professional judgment to appropriately tailor verification requirements for each project.

Validation

9.2.4 The project proponent shall submit the PDD for project validation by the VVB. The PDD shall contain sufficient information to demonstrate that the project's requirements adhere to the principles of this methodology, with respect to :

a. Additionality (see chapter 4).

b. Sustainable biomass (see Appendix C).

c. Storage and permanence requirements (see chapter 8).

d. Monitoring plan (see Appendix I).

e. Project boundaries (see chapter 3).

f. Quantification (see chapter 7).

g. Materiality assessments for leakages (see chapter 6).

h. Baseline (see chapter 5).

i. Safeguards (see Appendix F).

j. VVB credentials.

9.2.5 The VVB shall assess the project's compliance with the principles of this methodology through a desk review of the information provided in the PDD (see Appendix J for indicative monitoring plan). In addition, the VVB shall at minimum carry out site visits to the proponent's biomass sourcing areas, capture facilities and storage sites to assess compliance with the methodology's sustainable biomass and storage and permanence requirements. The VVB may define the frequency and nature of such site visits, as well as any additional checks that are deemed necessary as part of project validation in the project data sampling and verification plan.

9.2.6 The project proponent may submit their PDD to the VVB ahead of project validation, to gain confidence that their operations will be compliant with the requirements of this methodology.

Verification

9.2.7 At the point of project validation, full and streamlined verifications, and validation renewals, the project proponent shall provide the VVB with all data points necessary, as defined in the monitoring plan.

9.2.8 The project proponent shall submit a full verification report, as a minimum, once per year for each calendar year after the year of initial project validation. This full verification report shall provide updates to all quantification variables as described in the monitoring tables in Appendix I. In addition, VVBs shall conduct the following actions on the full verification report:

a. Assess alignment of biomass sourcing sites with sustainable biomass sourcing requirements in Appendix C.

b. Assess carbon capture site alignment with methodology requirements in chapter 2.

c. Assess alignment of injection and storage sites with requirements shown in chapter 8.

d. Confirm that project boundaries are accurate and relevant (as described in chapter 3).

e. Review materiality assessments for leakages (see chapter 6) to ensure they are accurate, and review the accuracy of any leakage required to be quantified and subtracted from the net removal quantification.

f. Validate that safeguard risks as detailed in Appendix F have been assessed, that risk assessments continue to be applicable, and that mitigation plans have been developed where necessary.

g. Disclosure of all areas of uncertainty. This may include any lapses in feedstock documentation, data irregularities, scientific uncertainty in LULUCF modelling for applicable regions, geological uncertainty involving formations or CO_2 plume modelling, and LCA considerations where subjective decisions were made regarding boundaries and exclusions of SSRs.

h. Confirm the applicability of VVB credentials against the requirements of clause 9.2.13.

9.2.9 The frequency of streamlined verifications (and credit issuance) is at the discretion of the project proponent.

9.2.10 Streamlined verifications will not be permitted if:

a. It has been more than 12 months since the last full verification.

b. A new VVB is used.

c. If the VVB cannot fulfil requirements of reasonable assurance given identified project risks.

d. The VVB concludes that significant risks or changes to project operations require more thorough review, such as changes to biomass sourcing policy or storage operator.

9.2.11 All reports may include additional elements from the monitoring plan, as requested by the VVB.

Validation/verification bodies

9.2.12 Verification bodies shall use professional judgment in tailoring a verification process appropriate for each validation and verification event.

9.2.13 All VVBs must be able to demonstrate accreditation from one of the following:

a. A domestic or international accreditation body pursuant to ISO 14064-3:2019, or to the most recent version of this standard.

b. The Clean Development Mechanism (CDM) Accreditation Standard for Designated Operational Entities.

c. A relevant governmental or intergovernmental regulatory body.

9.2.14 Any conflict of interest must be avoided according to ISO 14065:2020. This includes potential conflicts of interest between the project proponent, VVBs, and individuals involved with the project and verification teams.

9.2.15 The level of assurance for each verification is to be reasonable, with a materiality threshold of +/- 2%. All credits issued are to be ex-post after a positive project validation and subsequent positive verification report.

Appendix A - Zero-rating of biomass and basis of removal

Biomass shall be treated in accordance with accounting conventions laid out in the 2006 IPCC Guidelines for National Greenhouse Gas Inventories and 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories.

In accordance, CO_2 emissions from biomass shall be zero-rated at the point of use: "Carbon dioxide (CO_2) emissions from the combustion of biomass or biomass-based products are captured within the CO_2 emissions in the Agriculture, Forestry and Other Land Use (AFOLU) sector through the estimated changes in carbon stocks from biomass harvest, even in cases where the emissions physically take place in other sectors. This approach to estimate and report all CO_2 emissions from biomass or biomass-based products in the AFOLU sector was introduced in the first IPCC guidelines for national greenhouse gas emissions (IPCC 1995), reflecting close linkages with data on biomass harvesting, and for the pragmatic reason to avoid double counting."[23]

The capture and permanent storage of CO_2 from biomass may therefore deliver permanent negative emissions:

"If the [carbon capture and storage] plant is supplied with biofuels, the corresponding CO_2 emissions will be zero (these are already included in national totals due to their treatment in the AFOLU sector), so the subtraction of the amount of gas transferred to long-term storage may give negative emissions. This is correct since if the biomass carbon is permanently stored, it is being removed from the atmosphere."[24]

To ensure overall climate benefit, it is therefore imperative that biomass sourced for BECCS has a neutral or positive impact on carbon stocks in the land sector. The sustainability criteria laid out in Appendix C are to ensure that only sources of biomass delivering an overall net removal of carbon from the atmosphere are credited, while further ensuring that overall ecosystem health is protected.

[23] 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 2, Chapter 2, 2.3.3.4

[24] 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 2, Chapter 2, 2.3.4

Appendix B – Countries initially assessed under storage and permanence requirements

The list below shows the jurisdictions against which the storage and permanence requirements in this methodology have been assessed. Only storage operators operating under these jurisdictions shall be considered compliant with the storage and permanence requirements expressed in chapter 8. Further countries will be added to the list over time as the methodology is expanded to more jurisdictions.

Applicable storage and permanence jurisdictions (as of October 2023) and local regulations on storage and permanence:

- European Economic Area (EEA):
    - The 2009/31/EC directive on the geological storage of carbon dioxide
- United States of America (USA)
    - At the federal level, the EPA's Class VI rules from 2010
    - Relevant state level regulations, for example Louisiana's 2009 geologic sequestration of carbon dioxide act
- United Kingdom (UK)
    - The storage of carbon dioxide regulations of 2010 and 2011.

Appendix C – Sustainability criteria for forest biomass

This appendix outlines the criteria that a project proponent must follow to ensure that the forest biomass used for BECCS is sustainable. Projects that fulfil the requirements below, or meet the exemption requirements, will be applicable for issuing CDR credits. Where biomass is sourced from multiple regions, each sourcing region shall comply with the requirements and provide appropriate evidence against the criteria below. Note that sustainability criteria for alternative biomass sources is detailed in Appendix K.[25]

Stable or increasing forest carbon stock

The project proponent shall conduct a carbon stock assessment for all sourcing areas that provide biomass inputs for BECCS processes. Assessments shall review changes in carbon stocks and conclude if the stock is stable, increasing, or declining. A carbon stock assessment shall be completed at project validation, and at each subsequent verification, and the results shall be verified by the VVB.

For projects sourcing biomass from territories larger than 5 million km^2, carbon stock assessments of the sourced biomass shall be conducted on the forest sourcing area level. For projects sourcing biomass from territories smaller than 5 million km^2, carbon stock assessments of the sourced biomass shall be conducted either on the:

a. Jurisdictional level as reported for forest land and harvested wood products within the LULUCF sector to UNFCCC; or

b. Forest sourcing area level.

Jurisdictional approach

For projects that assess carbon stock changes at the jurisdictional level, national statistics for forest land and harvested wood products submitted to UNFCCC are required to demonstrate compliance with this carbon stock principle. Carbon stock changes shall be assessed using an average of the last five years of available UNFCCC data representing changes in emissions of forest lands and harvested wood products reported within the LULUCF sector[26]. This 'rolling average' shall be calculated with the most recently available primary data to the jurisdiction at each point of verification. Carbon stocks will be considered stable or increasing where the rolling average of these emissions is zero or negative[27], whereby a negative value represents an increase in carbon stocks.

[25] As of version 0.9, requirements for agricultural biomass have not yet been developed.

[26] It is recognized that there is a delay in collecting LULUCF data submitted to UNFCCC, hence a five year rolling average is the preferred calculation approach.

[27] In UNFCCC inventories, an increase in land carbon stocks is reported as a negative value since this corresponds to negative emissions.

Forest sourcing area approach

For assessments completed at the forest sourcing area level, assessment shall be conducted based on changes in carbon stock on attributable managed lands within the sourcing region. For undertaking the assessment, the following requirements shall be adhered to:

- Assessment shall, as a minimum, consider carbon stock change in above ground biomass. Below ground biomass, carbon in dead matter and carbon in soils may either be quantified, or evidence provided, that such carbon stocks are not negatively impacted.
- Assessments shall compare changes in carbon stocks using an average of the last five years of available data. This 'rolling average' shall be calculated with the most recently available primary data for each sourcing area, and at each point of verification. Carbon stocks will be considered stable or increasing where the rolling average is zero or positive.
- Priority shall be given to data sources underlying the development of national LULUCF inventories. Use of alternative data sources (e.g. bespoke remote sensing) shall be duly justified, with particular consideration given to data accuracy and reliability.

In exceptional circumstances, the carbon stock principle may still be fulfilled for biomass sourced from areas with declining carbon stocks. This applies for both jurisdictional and forest sourcing area approaches. Such exceptions will only be allowed where a third party VVB concludes that:

- A reduction in carbon stock within the assessment area is beyond the reasonable control of the project proponent and is not a result of over-harvesting of forests. Relevant examples may include:
    - Excessive levels of natural disturbance such as fire, earthquake, or pests.
    - Reductions were planned to stabilize or reverse the decline of future forest carbon stock (e.g. thinning to reduce fire risk in regions prone to fire damage).
- A mitigation plan is in place to stabilize or reverse the decline of carbon stocks.

Sustainable management of forests and maintenance of biodiversity

Biomass shall be sourced from sustainably managed forests requiring that:

a. The country in which forest biomass was harvested has national or sub-national laws applicable in the area of harvest as well as monitoring and enforcement systems; or

b. Management systems are in place at the forest sourcing area ensuring:
    - Legality of harvesting operations
    - Forest regeneration of harvested areas
    - That areas designated by international or national law, or by the relevant competent authority for nature protection purposes, are protected with the aim of preserving biodiversity and preventing habitat destruction.

- That harvesting is carried out considering maintenance of soil quality and biodiversity according to sustainable forest management principles, with the aim of preventing negative impacts in a way that:
    - Avoids harvesting of stumps and roots.
    - Avoids harvesting on vulnerable soils.
    - Ensures harvesting of large clear-cuts is within maximum thresholds as defined in the country where the forest is located.
    - Ensures extraction of deadwood adheres to locally and ecologically appropriate retention thresholds.
    - Ensures logging systems minimize impacts on soil quality and biodiversity features and habitats.
- That harvesting maintains or improves the long-term production capacity of the forest.

From an EU perspective, the criteria of this section leverage the EU RED Article 29.6, as amended by REDIII.

Protection of primary forests and other highly biodiverse ecosystems

Biomass shall not be sourced from lands with high biodiversity value, namely:

a. Primary forest, defined as woodland of native species where there is no clearly visible indication of human activity and the ecological processes are not significantly disturbed; and old growth forest, as defined in the legislation of the country in which the forest is located.
b. Highly biodiverse forest, as identified by the relevant competent authority, unless evidence is provided that the harvesting of the biomass does not interfere with those nature protection purposes.
c. Highly biodiverse grassland.

From an EU perspective, the criteria of this section leverage the EU RED Article 29.3 and 29.6 as amended by REDIII.

Protection of high carbon stock lands

Biomass shall not be sourced from lands recently converted from a status with high carbon stock value, namely:

a. Wetlands.
b. Peatland, unless evidence is provided that the cultivation and harvesting of that raw material does not involve drainage of previously undrained soil.

From an EU perspective, the criteria of this section leverage the EU RED Article 29.4 & 29.5, as amended by REDIII.

Long-lived wood products

To protect harvested wood product-based carbon sinks and their climate benefit in substituting carbon intensive products, biomass shall not be sourced from material suitable for use in long-lived wood products such as sawtimber or veneer within the sourcing area.

Sources of roundwood, whose characteristics make them unsuitable for use in higher value markets when considering forest, market, and logistical conditions, are eligible. Sources may include thinning, pulpwood, or down-graded wood due to fire, storms, infestation, fungus or fiber that is logistically or otherwise unsuitable for use in long-lived products.

Corruption

Biomass shall not be sourced from any country with a Corruption Perception Index[28] <50, except where a supplier demonstrates adequate mitigation of the risk of corruption.

Exemptions

Post-consumer forms of biomass (e.g. wood waste) shall be exempt from the sustainability criteria. However, such forms require verification that the waste has not been deliberately produced for the purposes of providing biomass for BECCS.

Biomass residues from processing (e.g. sawmill residues) shall be exempt from the 'Stable or increasing forest carbon stock' criteria on the basis that demand for such biomass has little influence over land management decisions and consequently carbon stock changes. All other sustainability criteria shall apply. However, due regard shall be given to traceability challenges for such material when considering evidence necessary to demonstrate adherence.

Traceability and mass balance

Biomass shall be traceable throughout the value chain using either a physical segregation or mass balance approach. Where using a mass balance approach, the mass balance system shall:

a. Allow consignments of biomass with differing sustainability and GHG characteristics to be mixed.

b. Allow consignments of biomass with differing energy content to be mixed for the purposes of further processing, provided that the size of consignments is adjusted according to energy content.

c. Ensure sustainability and GHG characteristics remain assigned to the mixture through the chain of custody.

d. Provide for the sum of all consignments withdrawn from the mixture to be described as having the same sustainability characteristics, in the same quantities, as the sum of all consignments added to the mixture and require that this balance be achieved over an appropriate period.

[28] 2022 Corruption Perceptions Index: Explore the... - Transparency.org

e. Ensure that sustainability and GHG characteristics are not double-counted across consignments.

f. Ensure that sustainable biomass is not mixed with illegally harvested sources.

Certification/Monitoring, reporting and verification (MRV)

Verification of biomass sources against biomass sustainability requirements in this methodology shall be demonstrated through one or more of three routes:

a. Certification – Biomass sources are verified against the relevant criteria through a biomass sustainability certification scheme, such as the Sustainable Biomass Programme (SBP), the Forestry Stewardship Council (FSC), the Programme for the Endorsement of Forest Certification (PEFC), the Sustainable Forestry Initiative (SFI) or Roundtable on Sustainable Biomaterials (RSB), and received with the requisite claim. Alternatively, verification against maintenance or improvement of forest carbon stock criteria may be conducted in accordance with relevant corporate GHG disclosure standards such as the GHG Protocol.

b. Regulatory compliance – Biomass sources' compliance with the sourcing principles are verified by a third party or by national authorities in accordance with sustainability criteria set out in national or jurisdictional regulation.

c. Independent assurance – Biomass is independently verified by a third party against the biomass sustainability requirements laid out in this methodology. Verification shall be conducted in accordance with ISAE 3000 limited assurance engagement or equivalent as a minimum. Verification shall be performed annually as a minimum.

Where verification of a biomass source may be partially demonstrated through certification or regulation, independent assurance (c) may be additionally used against those requirements not covered. Where using a combination of both certification/regulation and independent assurance, it shall be clearly demonstrated which requirements are met through certification and regulation and which are met through independent assurance.

Non-compliance

If any consignments of sourced biomass fail to fulfil the requirements in this section, and do not fulfil the exception criteria described, then the project proponent shall not be issued with CDR credits from CO_2 removal volumes derived from these consignments.

The project proponent shall decrease issuance of net removal certificates by the proportion of biomass feedstock sourced from consignments that fail to fulfil sustainability criteria, compared to the total volume of biomass feedstock sourced for the BECCS process. Compliance with the criteria shall be assessed based on the best available evidence at the time of crediting.

Revisions

The sustainability criteria apply a risk averse approach to biomass sourcing. However, it is duly recognized that there can be substantial potential benefits of improved forest management within forests of high ecological value (including both carbon stocks and biodiversity), particularly in forests prone to natural disturbance events exacerbated by climate change.

These criteria will therefore be subject to continuous review to ensure that the principles remain aligned with the latest scientific consensus on biomass sourcing, with a view to delivering meaningful climate and nature benefit through improved forest management.

Appendix D – Energy leakage

Energy leakage is defined as the emissions impact from a rise in overall energy intensity resulting from CCS operations (e.g. an increased grid emissions factor or changes in heat emissions intensity). It is distinct from direct emissions from CCS operation, which are accounted for within the project boundary. Energy leakage is considered a form of market leakage under the classification structure defined in chapter 6. The treatment of energy leakage in this methodology depends both on the type of BECCS project – retrofit or new-build – and on the policy environment in which the project proponent operates.

Requirements

Project type

New-build BECCS power and/or heat plants lower grid and/or heat energy intensity by adding new zero-rated energy capacity (see chapter 5). Therefore, new-build BECCS projects do not require any energy leakage adjustments.

Energy leakage only needs to be assessed, therefore, in the case of retrofit BECCS projects. Due to the addition of CCS installations, a BECCS plant may supply less net energy to the grid compared to the baseline, thereby potentially increasing energy emission intensity.[29] If a retrofit BECCS project supplies less energy to the grid than before the project commencement, then the project proponent shall make energy leakage adjustments as described below. However, if a project proponent can demonstrate that the CCS project has increased plant energy output, they do not need to make any adjustments for energy leakage as it can be seen to add to renewable capacity. In the case of retrofit BECCS, the VVB shall assess the evidence of changes in energy output and outline whether any energy leakage adjustments will be required.

Policy environment

In jurisdictions with cap-and-trade schemes in place covering the power and heat generation sectors, energy leakage is non-material because any increase in energy emissions resulting from increased CCS energy use will necessitate reductions in emissions from other parts of the energy system due to the jurisdictional emissions cap. In this case, the CCS component of a retrofit BECCS project cannot be said to create energy leakage, as the emissions must be reduced from elsewhere in the energy system to keep emissions from the power and heat sector in line with the emissions cap.

In jurisdictions without cap-and-trade systems for the power and heat sectors, the project proponent shall quantify net energy leakage emissions and subtract them from net removals.

[29] Note that for combined heat and power (CHP) plants, the effect on emissions intensity of heat may be the opposite. The project proponent shall assess this prior to each credit issuance.

Assessment

In cases where assessment of energy leakage is required, the project proponent shall estimate the additional emissions that are being generated through the impact on regional grid emissions intensity resulting from retrofit CCS energy using the following equation:

$$MLE = (PXB - PXP) \times PGI + (HXB - HXP) \times HGI$$

MLE	Emissions from market leakages	tonnes of CO_2e
PXB	Power delivered to the grid in baseline	MWh
PXP	Power delivered to the grid by the plant	MWh
PGI	Power grid carbon intensity	Tonnes of CO_2e/MWh
HXB	Heat delivered to the grid in baseline	MWh
HXP	Heat delivered to the grid by the plant	MWh
HGI	Heat grid carbon intensity	Tonnes of CO_2e/MWh

In case the change in power and heat production in the BECCS plant impacts the Project proponent's production system, including possible regional cooperation for heat, such impacts shall be included in the calculation above. For example, increased heat delivery from the BECCS plant may reduce the need for electricity in centralised heat pumps. Additional guidance will be provided in due course on how to account for change in carbon leakage over time, particularly for situations where energy delivered in the baseline and grid carbon intensities are anticipated to change over time.

In cases where the regional electricity grid emission factor is less than 18g CO_2e/MJ, leakage can be assumed to be zero.[30] The regional electricity grid is defined as the bidding zone and/or national grid where the different CCS facilities are located.

Retrofit BECCS plants where fuel switching from fossil fuel to sustainable biomass occurs (e.g. conversion from coal) is not considered to result in energy leakage, provided that the avoided emissions occurring as a result of the fuel switching activity is not separately credited under the voluntary carbon market. To be considered under this condition, the bioenergy power and/or heat plant shall have been operational for less than or equal to 48 months prior to installation of the CCS equipment.

[30] This is based on the European Union's Delegated Act rules on hydrogen production, which allow for fuels produced using electricity from a grid with emissions intensity of less than 18g CO2e/MJ to be classified as renewable. Delegated Act available at: https://energy.ec.europa.eu/delegated-regulation-union-methodology-rnfbos_en

Appendix E – Stakeholder consultation and grievance mechanism requirements

Stakeholder consultation requirements

For new-build BECCS facilities, the project proponent shall conduct a public consultation prior to breaking ground on the project. For retrofit projects, this is only necessary where the project will expand the physical footprint of the facility (e.g. additional pipelines, or expanded plant boundaries). This is to ensure that public feedback is considered, and any concerns are addressed appropriately by the time the project becomes operational.

To promote inclusivity, the project proponent shall identify and invite all relevant stakeholders to engage with the project development process. Those invited shall include, as a minimum:

- Representatives from local governing bodies.
- Relevant non-governmental organizations (NGOs).
- Residents from surrounding areas where the project will be located.

A physical or an online meeting link shall be set up for all consultations – to at least allow virtual participation in circumstances where all stakeholders cannot join meetings in-person. Invites shall be sent out no less than one month in advance to allow time for participants to plan to attend. Invites shall include the date, time, venue, reason for organizing the public consultation, and live link to the online meeting. Some consultations may be offered on a single stakeholder basis, as appropriate.

The project proponent shall prepare documentation with evidence and outcomes of the consultations, which shall include at least the following:

- List of invitees/target groups.
- List of attendees.
- Agenda of the meeting.
- Minutes of the meeting.
- Questions and feedback received from participants, including responses by the project proponent to those questions and any subsequent actions to be carried out.

At the point of validation, the project proponent shall demonstrate to the VVB what action, if any, they have taken as a result of local stakeholder consultation and the reasons for taking, or not taking, action.

Grievance mechanism

Simultaneous to planning and organizing public consultation, the project proponent shall create and adopt a grievance redressal mechanism or equivalent community engagement mechanism. The project proponent shall make all stakeholders aware of the mechanism and its uses. The grievance redressal

mechanism will allow any parties affected by the project and acting in good faith to provide feedback or grievances directly to the project proponent. The grievance mechanism must be available through both the implementation and operation phases of the project, and have easily accessible points of contact such as:

- A dedicated email address.
- A help desk phoneline.
- An in-person help desk at a local office of the project.

The project proponent shall respond to grievances raised also in good faith and maintain a log of all grievances received, and their resolution, throughout the crediting period of the project. The project proponent may wish to publish grievance and resolution logs on relevant project websites to provide transparency to affected stakeholders, and to encourage public participation through the life of the project.

Appendix F – Safeguards

The BECCS project shall adhere to safeguards which ensure that any negative social and environmental impacts are considered and mitigated.

At the point of project validation, the project proponent must demonstrate that the project, including business partners, has obtained all required relevant environmental and business permits in the jurisdictions of sourcing, capture and storage operations. These safeguards shall apply to all stages of the BECCS value chain, including biomass sourcing, carbon capture and processing sites, CO_2 transportation, injection, and storage. Furthermore, the project proponent shall review the full list of sustainable safeguards outlined below and confirm that they have considered each and, where requested, provide the VVB with copies of the assessments provided and mitigations to be implemented.

Assessment and management of environmental and social risks

- Abide by national and local laws, objectives, programs and regulations and, where relevant, international conventions and agreements; assess risks of negative environmental and social impacts with regard to the safeguards.
- Ensure free, prior and informed Consent (FPIC) processes for Indigenous Peoples (IPs) and Local Communities (LCs), where applicable, and conduct reasonable stakeholder consultations, including local stakeholders, as part of project design and implementation.

Labour rights and working conditions

- Provide safe and healthy working conditions for employees.
- Provide fair treatment of all employees, avoiding discrimination and ensuring equal opportunities.
- Prohibit the use of forced labour, child labour, or trafficked persons, and protect contracted workers employed by third parties.

Resource efficiency and pollution prevention

Comply with regulatory-defined limits for:

- Local air and water pollution
- Noise and vibration generation
- Waste generation or release of hazardous materials, chemical pesticides and fertilizers.

Land acquisition and involuntary resettlement

- Avoid, or where this is not feasible, minimize forced physical and or economic displacement.

Biodiversity conservation and sustainable management of living natural resources

- Avoid, or where this is not feasible, minimize negative impacts on terrestrial and marine biodiversity and ecosystems.
- Protect the habitats of rare, threatened, and endangered species, including areas needed for habitat connectivity.
- Not convert natural forests, grasslands, wetlands, or high conservation value habitats.
- Comply with regulatory-defined limits for:
    - soil degradation and soil erosion.
    - water consumption and stress in the mitigation activity.

Indigenous peoples (IPs), local communities (LCs) and local heritage

- Recognize, respect and promote the protection of the rights of IPs and LCs in line with applicable international human rights law, and the United Nations Declaration on the Rights of Indigenous Peoples and ILO Convention 169 on Indigenous and Tribal Peoples.
- Identify the rights-holders possibly affected by the mitigation activity (including customary rights of local rights holders).
- Apply, when relevant to circumstances, the FPIC process.
- Not force eviction or any physical or economic displacement of IPs and LCs, including through access restrictions to lands, territories, or resources, unless agreed upon with IPs and LCs during the FPIC process.
- Preserve and protect cultural heritage consistent with IPs and LCs protocols/rules/plans on the management of cultural heritage or UNESCO Cultural Heritage conventions.

Respect for human rights, stakeholder engagement

- Avoid discrimination and respects human rights.
- Abide by the International Bill of Human Rights and universal instruments ratified by the host country.
- Consider and respond to local stakeholders' views.

Gender equality

- Provide for equal opportunities in the context of gender.
- Protect against, and appropriately respond to, violence against women and girls.
- Provide equal pay for equal work.

Appendix G – Emissions included or excluded from the project boundary

Table 2 Emissions sources and sinks included in, or excluded from, the project boundary

Baseline or project and/or quantification	Source or sink category	Included or excluded from project boundary	Included or excluded from quantification	Justification/description
Baseline	Non-CCS supply chain energy emissions	Excluded	Excluded	Operational supply chain emissions that are allocated to the energy (power or heat) output of the system. Can be zero in the case of new-builds.
Baseline	Non-CCS bioenergy plant construction	Excluded	Excluded for retrofits / Included for new-builds	In the case where a bioenergy plant is retrofitted with CCS, bioenergy plant construction emissions would have occurred anyway in the absence of the CCS project.
Baseline	Non-BECCS specific biomass cultivation and harvesting	Excluded	Excluded	Emissions from the cultivation and harvesting of biomass for purposes other than BECCS would have occurred anyway in the absence of the CCS project.
Baseline	BECCS-relevant infrastructure emissions	Excluded	Excluded	Embodied emissions from the construction of shared infrastructure that existed prior to the BECCS project that is used by BECCS operations (e.g. roads, pipelines) would have occurred anyway in the absence of the CCS project. This assumes that one BECCS plant will not be a significant driver of the development of carbon storage clusters. Furthermore, in most cases, BECCS will be built where there has been a prior decision to build a storage cluster (and not vice versa).
Project boundary & quantification	Gross CO_2 captured	Included	Included	CO_2 would not have been captured absent the CCS project

Baseline or project and/or quantification	Source or sink category	Included or excluded from project boundary	Included or excluded from quantification	Justification/description
Project boundary & quantification	Fugitive emissions from carbon capture	Included	Included	Fugitive emissions are directly caused by the CCS project and would not have occurred without it. They must be included in the net removals quantification.
Project boundary & quantification	Fugitive emissions from CO_2 transport	Included	Included	Same as above.
Project boundary & quantification	Fugitive emissions from injection	Included	Included	Same as above.
Quantification	Biomass cultivation and harvesting emissions (operational supply chain emissions)	Excluded	Included	Emissions from the cultivation and harvesting of biomass for BECCS purposes (e.g. collection of residues) are not directly related to the project. However they are included in the net removals quantification for conservativeness with an allocation factor if shared with energy products.
Quantification	Biomass processing emissions (operational supply chain emissions)	Excluded	Included	Same as above.
Quantification	Feedstock transportation emissions (operational supply chain emissions)	Excluded	Included	Same as above.
Quantification	Waste disposal emissions (ash) (operational supply chain emissions)	Excluded	Included	Same as above.
Project boundary & quantification	Energy production emissions (CCS project emissions)	Included	Included	Emissions resulting from the burning of fossil fuels to start up the biomass incineration process are directly related to the project. They are included in the net removals quantification for conservativeness with an allocation factor if shared with energy products.

Baseline or project and/or quantification	Source or sink category	Included or excluded from project boundary	Included or excluded from quantification	Justification/description
Project boundary & quantification	Carbon capture emissions (CCS project emissions)	Included	Included	Same as above.
Project boundary & quantification	Carbon processing emissions (CCS project emissions)	Included	Included	Same as above.
Project boundary & quantification	Carbon storage emissions (CCS project emissions)	Included	Included	Same as above.
Project boundary & quantification	Carbon capture construction emissions (CCS project emissions)	Included	Included	Emissions associated with the installation of CCS equipment are directly related to the project and quantified in the net removals calculation. This also applies to bioenergy plant construction emissions in the case of a new-build.
Quantification	Upstream/downstream emissions (leakage emissions)	Excluded	Included	Leakage emissions are not directly related to the project. However they are included in the net removals quantification for conservativeness.
Quantification	Activity-shifting (leakage emissions)	Excluded	Included	Same as above.
Quantification	Market leakage (leakage emissions)	Excluded	Included	Same as above.
Quantification	Ecological leakage (leakage emissions)	Excluded	Included	Same as above.

Appendix H – Registry requirements

The application of the methodology must be compatible with a registry that follows the requirements detailed in this appendix. A registry is a standardized platform for the issuance, trading, and retirement of carbon credits that provides a system for verifying the validity and authenticity of the credits, and for ensuring they are not double-counted or sold more than once. The registry can be held by a certification body, a body appointed by national authorities, or by an international organization.

The registry shall operate a system that can uniquely identify each CDR credit, associated physical carbon removals, ownership of the credit, and any other relevant attributes. It shall have open interfaces to allow for cost-efficient integration with multiple CDR credit trading platforms and national or international registries for host nation positions.

The registry shall carry the following information for each CDR credit:

- Serial number
- Issuing organization
- Issue date
- Last cancellation date
- Feedstock (biomass or air)
- Capture company
- Capture plant
- Capture method
- Transportation method
- Storage location
- Storage method, with permanence classification ("Geological storage")
- Reversal mechanism
- Transaction chain (price, date of sale, seller and purchaser)
- Cancellation date
- Cancelling party (holding corporation at the time of cancellation)
- Volume (standardized to 1 tonne or appropriate multiple thereof)
- Amount of CO_2 subtracted from gross tonne injected to arrive at net tonne (for issuance as CDR credits)

It is noted that credits issued under this methodology are traded between corporations for voluntary purposes and corporate climate target claims. Consequently, it is possible that the underlying physical

removal and storage of CO_2 may in parallel be claimed by host nations for the achievement of national climate targets. This is consistent with the VCMI Claims Code of Practice requirements for reporting high-quality carbon credits: "In the absence of a host country's authorization and subsequent corresponding adjustment, companies must publicly communicate that the mitigation underlying the carbon credit may also be counted towards the host country's NDC."[31]

[31] Voluntary Carbon Markets Initiative, 2023. Claims Code of Practice, Annex C. Available at: https://vcmintegrity.org/wp-content/uploads/2023/06/VCMI-Claims-Code-of-Practice.pdf

Appendix I – Managing data

This appendix details how the project proponent must monitor, document and report all metrics identified within this methodology. Following this guidance will ensure the project proponent measures and confirms carbon removed and long-term storage compliance, and will enable quantification of the emissions removal resulting from the project activity during the project crediting period, prior to each verification.

This methodology utilizes a comprehensive monitoring and documentation framework that captures the GHG impact in each stage of a BECCS project. Monitoring and detailed accounting practices must be conducted throughout to ensure the continuous integrity of the carbon removals and crediting.

Requirements

- The project proponent must develop and apply a monitoring plan according to ISO 14064-2 principles of transparency and accuracy that allows the quantification and proof of GHG emissions removals.
- The project proponent must monitor all the parameters listed below to ensure proper operation under this methodology.

Table 3 Monitoring tables

Monitoring table 1:

Data/Parameters	**Gross CO_2 injected**
Equation	Equation 2
Source of data	Measurements at injection sites
Description of measurement methods	Metered volume
Frequency of monitoring/recording	Measured continuously at injection location.
QA/QC procedures to be applied	Meters/scales must be calibrated as per local/national standards or as per manufacturer specifications. Some regulatory regimes (e.g. IRA 45Q) require following certain published standards and have specific calibration requirements. The project proponent must evaluate program-specific requirements as needed, while meeting those in this methodology.
Purpose of data	To quantify and provide proof of CO_2 injected.
Comments	n/a

Monitoring table 2:

Data/Parameters	**Gross CO_2 captured**
Equation	Equation 2
Source of data	Measurements at capture sites
Description of measurement methods	Metered volume
Frequency of monitoring/recording	Measured continuously at capture location, at transportation pickup, at time of delivery to storage site, and at time of each injection.
QA/QC procedures to be applied	Meters/scales must be calibrated as per local/national standards or as per manufacturer specifications. Some regulatory regimes (e.g. IRA 45Q) require following certain published standards and have specific calibration requirements. The project proponent must evaluate program-specific requirements as needed, while meeting those in this methodology.
Purpose of Data	To quantify and provide proof of emissions captured.
Comments	n/a

Monitoring table 3

Data/Parameters	**CO_2 transport fugitive emissions (optional[32])**
Equation	Equation 2
Source of data	Monitoring table 12
Description of measurement methods	Difference between metered capture and delivered amounts. May use disaggregated default values where metered values are not available.
Frequency of monitoring/recording	Averaged over reporting period not exceeding 1 year.
QA/QC procedures to be applied	Meters/scales must be calibrated as per local/national standards or as per manufacturer specifications. Some regulatory regimes (e.g. IRA 45Q) require following certain published standards and have specific calibration requirements. The project proponent must evaluate program-specific requirements as needed, while meeting those in this methodology.

[32] Fugitive emissions only need to be monitored if the project proponent must estimate gross volumes of CO_2 injected based on gross CO_2 captured, due to the unavailability of injected CO_2 volume certificates.

Purpose of data	To identify volume of fugitive emissions from CO_2 transportation that shall be subtracted from gross CO_2 removals.
Comments	n/a

Monitoring table 4:

Data/Parameters	**Injection fugitive emissions (optional[33])**
Equation	Equation 2
Source of data	Monitoring table 12
Description of measurement methods	Difference between delivered and injected metered amounts. May use disaggregated default values where metered values are not available.
Frequency of monitoring/recording	At time of each injection
QA/QC procedures to be applied	Meters/scales must be calibrated as per local/national standards or as per manufacturer specifications. Some regulatory regimes (e.g. IRA 45Q) require following certain published standards and have specific calibration requirements. The project proponent must evaluate program-specific requirements as needed, while meeting those in this methodology.
Purpose of data	To identify any reversals from storage processing.
Comments	n/a

Monitoring table 5:

Data/Parameters	**Biomass cultivation and harvesting emissions**
Equation	Equation 3
Source of data	Biomass producer or disaggregated default values when direct measurement is impossible.
Description of measurement methods	Energy use multiplied by emission factors. Disaggregated default values can be used when direct measurement is impossible.

[33] Fugitive emissions only need to be monitored if the project proponent must estimate gross volumes of CO_2 injected based on gross CO_2 captured, due to the unavailability of injected CO_2 volume certificates.

Frequency of monitoring/recording	Average over reporting period not exceeding 1 year, applied per consignment.
QA/QC procedures to be applied	Review of factors and processing procedures.
Purpose of data	To quantify emissions directly attributable to the cultivation of biomass for BECCS purposes, e.g. collection of residues.
Comments	n/a

Monitoring table 6:

Data/Parameters	**Biomass processing emissions**
Equation	Equation 3
Source of data	Biomass processing facility or disaggregated default values when direct measurement is impossible.
Description of measurement methods	Energy use multiplied by emission factors. Disaggregated default values can be used when direct measurement is impossible.
Frequency of monitoring/recording	Average over reporting period not exceeding 1 year, applied per consignment.
QA/QC procedures to be applied	Review of factors and processing procedures.
Purpose of data	To quantify emissions from biomass processing for the BECCS plant. May include pelletizing, drying, etc.
Comments	n/a

Monitoring table 7:

Data/Parameters	**Waste disposal emissions**
Equation	Equation 3
Source of data	BECCS plant management data or disaggregated default values when direct measurement is impossible.
Description of measurement methods	Measured volume, distance moved and emissions factors.
Frequency of monitoring/recording	Continuous monitoring, averaged over reporting period not exceeding 1 year, applied per consignment.
QA/QC procedures to be applied	Review of factors, scale calibration as per local/national standards or as per manufacturer specifications, and removal procedures.

Purpose of data	To quantify emissions from the BECCS plant waste management process.
Comments	Must include all emissions from onsite machinery as well as vehicles removing waste to landfill or other disposal site.

Monitoring table 8:

Data/Parameters	**Biomass feedstock transportation emissions**
Equation	Equation 3
Source of data	Energy use (based on transport distance and transportation type's fuel economy in unit of energy/distance per tonne transported) multiplied by an emissions factor for the transportation mode and fuel type.
Description of measurement methods	Measured transport distance, fuel economy of transportation mode (in unit of energy/distance per tonne transported), emission factor relevant to transportation mode and fuel type.
Frequency of monitoring/recording	Average over reporting period not exceeding 1 year, applied per consignment.
QA/QC procedures to be applied	Review assumptions, parameters and measurement methods.
Purpose of data	To quantify emissions from feedstock transport.
Comments	n/a

Monitoring table 9:

Data/Parameters	**CH_4 emissions from energy production**
Equation	Equation 5
Source of data	Emissions factors for energy production multiplied by volume of feedstock or by energy produced (depending on factor used).
Description of measurement methods	Either volume measured or metered energy production.
Frequency of monitoring/recording	Average over reporting period not exceeding 1 year.
QA/QC procedures to be applied	Meters/scales must be calibrated as per local/national standards or as per manufacturer specifications. Some regulatory regimes (e.g. IRA 45Q) require following

	certain published standards and have specific calibration requirements. The project proponent must evaluate program specifics as needed.
Purpose of data	To account for emissions from energy production through biomass combustion.
Comments	n/a

Monitoring table 10:

Data/Parameters	**N_2O emissions from energy production**
Equation	Equation 5
Source of data	Emissions factors for energy production multiplied by volume of feedstock or by energy produced (depending on factor used).
Description of measurement methods	Either volume measured or metered energy production.
Frequency of monitoring/recording	Average over reporting period not exceeding 1 year.
QA/QC procedures to be applied	Meters/scales must be calibrated as per local/national standards or as per manufacturer specifications. Some regulatory regimes (e.g. IRA 45Q) require following certain published standards and have specific calibration requirements. The project proponent must evaluate program specifics as needed.
Purpose of data	To account for emissions from energy production through biomass combustion.
Comments	n/a

Monitoring table 11:

Data/Parameters	**Other emissions sources from energy production**
Equation	Equation 5
Source of data	Energy use multiplied by emissions factors.
Description of measurement methods	Metered energy use.
Frequency of monitoring/recording	Average over reporting period not exceeding 1 year.
QA/QC procedures to be applied	Meters/scales must be calibrated as per local/national standards or as per manufacturer specifications. Some regulatory regimes (e.g. IRA 45Q) require following certain published standards and have specific calibration

	requirements. The project proponent must evaluate program specifics as needed.
Purpose of data	To account for all emissions from energy production.
Comments	This category will be used if energy sources outside of biomass are used to start up or maintain energy production facilities (e.g. grid electricity, natural gas)

Monitoring table 12:

Data/Parameters	**Carbon capture energy use emissions**
Equation	Equation 6
Source of data	Energy use multiplied by emissions factors.
Description of measurement methods	Metered energy use.
Frequency of monitoring/recording	Continuous.
QA/QC procedures to be applied	Meters/scales must be calibrated as per local/national standards or as per manufacturer specifications. Some regulatory regimes (e.g. IRA 45Q) require following certain published standards and have specific calibration requirements. The project proponent must evaluate program specifics as needed.
Purpose of data	To account for energy use emissions from carbon capture technology use.
Comments	Will vary depending upon energy source. This will account for CO_2, N_2O, and CH_4 emissions. If energy source is biomass compliant with the sustainability requirements under this methodology, and produced by the generators where carbon capture occurs, then this category will be used as all emissions will be included in the energy production emissions calculation (equation 3).

Monitoring table 13:

Data/Parameters	**Carbon capture emissions from chemicals use in capture process**
Equation	Equation 6
Source of data	Inventory of chemical use and technical specifications on carbon capture devices.

Description of measurement methods	Volume measurement and emissions factors.
Frequency of monitoring/recording	Average over reporting period not exceeding 1 year.
QA/QC procedures to be applied	Redundancy with comparison to chemical use volume.
Purpose of data	Calculate emissions from carbon capture systems chemical use.
Comments	Will vary depending on technology.

Monitoring table 14:

Data/Parameters	**Carbon capture emissions from production of chemicals used in capture processes**
Equation	Equation 6
Source of data	Inventory of chemicals' embodied carbon and technical specifications on carbon capture devices.
Description of measurement methods	Volume measurement and emissions factors.
Frequency of monitoring/recording	Average over reporting period not exceeding 1 year.
QA/QC procedures to be applied	Redundancy with comparison to chemical use volume.
Purpose of data	Calculate embodied emissions from carbon capture systems chemical use.
Comments	n/a

Monitoring table 15:

Data/Parameters	**CO_2 processing, compression and dehydration emissions**
Equation	Equation 4
Source of data	Energy use (in units of fuel/energy per volume of CO_2 captured) multiplied by an emissions factor for the processing type.
Description of measurement methods	Metered energy use from capture and/or CO_2 transport operator.
Frequency of monitoring/recording	Average over reporting period not exceeding 1 year.
QA/QC procedures to be applied	Review assumptions, parameters and measurement methods
Purpose of data	To quantify emissions from captured CO_2 processing, compression and dehydration.
Comments	n/a

Monitoring table 16:

Data/Parameters	**CO_2 transport emissions**
Equation	Equation 4
Source of data	Energy use (based on transport distance and transportation type's fuel economy in unit of energy/distance per tonne transported) multiplied by an emissions factor for the transportation mode and fuel type.
Description of measurement methods	Measured transport distance, fuel economy of transportation mode (in unit of energy/distance per tonne transported), emission factor relevant to transportation mode and fuel type.
Frequency of monitoring/recording	Average over reporting period not exceeding 1 year, applied per consignment.
QA/QC procedures to be applied	Review assumptions, parameters and measurement methods.
Purpose of data	To quantify emissions from captured CO_2 transport.
Comments	n/a

Monitoring table 17:

Data/Parameters	**CO_2 injection and storage emissions**
Equation	Equation 4
Source of data	Storage operator.
Description of measurement methods	Energy use emissions factor multiplied by CO_2 injected (as measured in monitoring table 12).
Frequency of monitoring/recording	Average over reporting period not exceeding 1 year, applied per consignment.
QA/QC procedures to be applied	Emission factor data source review.
Purpose of data	To determine emissions from storage.
Comments	If emissions factor is not in CO_{2e} factors must be collected for N_2O and CH.

Monitoring table 18:

Data/Parameters	**Embodied CO_2 emissions from construction and installation**
Equation	Equation 4
Source of data	Construction company.
Description of measurement methods	Multiply size of building and infrastructure with embodied carbon emissions factor that measures CO_2 lifecycle emissions associated with materials and construction processes.
Frequency of monitoring/recording	Measured once, after carbon capture equipment construction, then amortized over crediting period as described in PDD.
QA/QC procedures to be applied	Review assumptions, parameters and measurement methods.
Purpose of data	To quantify emissions associated with materials and construction of carbon capture, transport and storage equipment.
Comments	n/a

Monitoring table 19:

Data/Parameters	**Carbon captured and stored originating from ancillary fuels** [34]
Equation	Equation 2
Source of data	Volume of ancillary fossil fuels burned (e.g. fuel used for biomass combustion start-up process or for use in regenerative thermal oxidisers) multiplied by emission factor multiplied by one minus capture rate.
Description of measurement methods	Volume measurement and emissions factors.
Frequency of monitoring/recording	Continuous.
QA/QC procedures to be applied	Meters/scales must be calibrated as per local/national standards or as per manufacturer specifications. Some regulatory regimes (e.g. IRA 45Q) require following certain published standards and have specific calibration requirements. The project proponent must evaluate program specifics as needed.

[34] Ancillary fuel CO_2 adjustment emissions only need to be monitored if the project proponent must estimate gross volumes of CO_2 injected based on gross CO_2 captured, due to the unavailability of injected CO_2 volume certificates.

Purpose of data	To account for emissions from energy production through biomass combustion.
Comments	n/a

Monitoring table 20:

Data/Parameters	**Adjustments**
Equation	Equation 8
Source of data	Dependent on exception criteria – at discretion of project proponent and VVB.
Description of measurement methods	Dependent on exception criteria – at discretion of project proponent and VVB.
Frequency of monitoring/recording	Dependent on exception criteria – at discretion of project proponent and VVB.
QA/QC procedures to be applied	Dependent on exception criteria – at discretion of project proponent and VVB.
Purpose of data	To account for unanticipated emissions arising from failure to meet criteria post credit issuance, e.g. sourcing from forests where carbon stocks are later found to be declining.
Comments	n/a

Monitoring table 21:

Data/Parameters	**Allocation factor**
Equation	Equation 8
Source of data	GHGP standard for the Allocation of GHG Emissions method[35] for allocating emissions between different energy products.
Description of measurement methods	Measurement methods in compliance with GHG Protocol.
Frequency of monitoring/recording	Average over reporting period not exceeding 1 year.
QA/QC procedures to be applied	At discretion of project proponent and VVB.
Purpose of data	In the case where bioenergy plant produces several energy products, operational supply chain emissions may

[35] GHG Protocol - Allocation of GHG emissions from a combined heat and power (CHP) plant, Guide to calculation worksheets (2017)

	be allocated as appropriate among these products (e.g. heat and electricity) in accordance with the GHGP standard for the Allocation of GHG Emissions.
Comments	n/a

Appendix J – Indicative monitoring plan

The tables provided below may be used to develop a project's monitoring plan as described in chapter 9. These are indicative templates that can be updated to reflect each project's specific requirements. Independent VVBs shall use their professional judgement to adapt reporting timelines and verification requirements to levels that are appropriate for each project, and their level of risk.

Table 4: Indicative reporting requirements

Reporting principle	PDD validation	Project validation	Streamlined verification	Full verification	Validation renewal
Additionality	**Demonstrate additionality**				**Re-confirm additionality**
Baseline	Define if project will be retrofit or new-build.	Confirm if built project is retrofit or new-build. Estimate allocation factor for non-CCS energy products for first quantification.		Re-assess allocation factor for non-CCS products.	
Sustainable biomass	Assess adherence to sustainable biomass principles of planned sourcing areas.	Confirm adherence of built project to all PDD validation requirements. Will require site visits.		Assess continued adherence to sustainable biomass principles, including carbon stock assessments.	Reassess adherence to sustainable biomass principles for all sourcing areas. Will require site visits.
Storage and permanence requirements	Assess planned storage site adherence to storage principles.	Confirm adherence of built project to all PDD validation requirements. Will require site visits.		Assess continued adherence to storage site principles (including enhanced hydrocarbon recovery).	Re-confirm adherence to storage principles for all sites.
Consultation and safeguards	Develop stakeholder consultation plan. Review safeguards and develop mitigation plans.	Confirm adherence to stakeholder consultation plan. Review safeguards and adherence to mitigation plans; recommend development of other mitigation plans if new issues identified.		Review safeguards and adherence to mitigation plans; recommend development of other mitigation plans if new issues identified.	Review safeguards and adherence to mitigation plans; recommend development of other mitigation plans if new issues identified.
Leakage	Assess leakage sources for materiality.	Confirm materiality of leakage sources.		Re-assess leakage sources for materiality.	

Reporting principle	PDD validation	Project validation	Streamlined verification	Full verification	Validation renewal
Additionality	**Demonstrate additionality**				**Re-confirm additionality**
Quantification	Calculate embodied emissions from construction and installation, over 15 year amortization period. Provide first projections for all variables required for net removals calculation.	Calculate embodied emissions from construction and installation, over 15 year amortization period. Provide first projections for all variables required for net removals calculation.	Provide data on all continuously monitored (i.e. metered) variables. Likely to include: • Gross injected CO_2 removal volumes. • Energy use emissions. • Energy generation emissions.	Provide data on all non-continuously monitored variables. Likely to include emissions from: • Upstream biomass harvesting, processing, and transportation. • Waste disposal. • CO_2 processing, transport, injection, and storage. • Energy leakage.	
Verification and reporting	Create project data sampling and verification plan. Provide confirmation of VVB credentials.	Confirm project data monitoring plan. Provide confirmation of VVB credentials.	Provide confirmation of VVB credentials to registry.	Provide confirmation of VVB credentials to registry.	Re-assess project monitoring plan. Provide confirmation of VVB credentials.

Table 5: Indicative frequency of updates to quantification variables

Quantification variable requirement	Streamlined verifications	Full verifications
Gross CO_2 injected	x	
Biomass cultivation and harvesting emissions		x
Biomass processing emissions		x
Emissions from feedstock transportation		x
Emissions from waste disposal		x
Energy production emissions (CH_4, N_2O, CO_2, other emissions)	x	
Carbon capture emissions from energy use	x	
Carbon capture emissions from chemical use	x	

Quantification variable requirement	Streamlined verifications	Full verifications
Emissions from CO_2 processing, compression and dehydration		x
Emissions from CO_2 transportation		x
Emissions from injection and storage		x
Emissions from construction and installation of carbon capture equipment[36]		
Allocation factor for operational supply chain emissions		x
Leakages (including energy leakage)		x
Other adjustments (as necessary)	x	

[36] Emissions from construction and installation of carbon capture equipment are only measured once, after construction, and are amortized over a 15-year period. Such emissions are reported in the PDD for project validation but not in the verification reports since they have occurred prior to the project and hence will not change over the course of the crediting period.

Appendix K - Sustainability criteria for alternative biomass sources

Future iterations of the methodology may be developed to accommodate alternative biomass sources, such as agricultural biomass (e.g. straw).

References

2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 2, Chapter 2 (2006)

2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 2, Chapter 2 (2019)

BEIS - Deep Geological Storage of CO_2 on the UK Continental Shelf - Containment Certainty (2023)

Criteria and standards applicable to Class VI injection wells (2010)

EU directive 2009/31/EC on the geological storage of carbon dioxide (2009)

GHG Protocol - Allocation of GHG emissions from a combined heat and power (CHP) plant, Guide to calculation worksheets (2017)

Gold Standard – Methodology for biomass fermentation with carbon capture and geologic storage – draft for public consultation (2023)

ICVCM Core carbon principles, assessment framework and assessment procedure (2023)

IPCC – Climate change 2021, The Physical science basis, Working Group I contribution to the sixth assessment report of the IPCC (2021)

IPCC - Special Report on Carbon dioxide Capture and Storage (2005)

IPCC special report on carbon dioxide capture and storage – Chapter 5 Underground geological storage (2005)

ISO 14033:2019 Environmental management — Quantitative environmental information — Guidelines and examples (2019)

ISO 14064-2:2019 Greenhouse gases — Part 2: Specification with guidance at the project level for quantification, monitoring and reporting of greenhouse gas emission reductions or removal enhancements (2019)

ISO 14064-3 2019 Greenhouse gases — Part 3: Specification with guidance for the verification and validation of greenhouse gas statements (2019)

ISO 27914:2017 Carbon dioxide capture, transportation and geological storage — Geological storage (2017)

ISO 9001:2015 Quality management (2015)

Louisiana geologic sequestration of carbon dioxide act (2009)

Proposal for a regulation of the European Parliament and of the Council establishing a Union certification framework for carbon removals (EU CRC-F), COM/2022/672 final (2022)

Puro.Earth – Geologically stored carbon methodology (2022)

The storage of carbon dioxide (Licensing etc.) regulation (2010)

The storage of carbon dioxide (Termination of Licenses) regulations (2011)

US Code 45Q – credit for carbon oxide sequestration (2008)

Glossary

Table 6 Definitions and abbreviations

Bioenergy with Carbon Capture Storage (BECCS)	Process in which sustainably sourced biomass is used in an industrial process that produces, for example, biofuels, electricity, heat or pulp; the resulting biogenic CO_2 emitted is captured and stored.
Carbon credit	Tradable instrument that represents the reduction or removal of one metric tonne of carbon dioxide or its equivalent in other greenhouse gases, which can be bought and sold on carbon markets to help individuals, organizations, or countries achieve their decarbonisation objectives.
Carbon Capture and Storage (CCS)	Process that captures carbon dioxide (CO_2) emissions from industrial processes, power plants, or the atmosphere, and stores them underground or in other long-term storage facilities.
Carbon Dioxide Removal (CDR)	Anthropogenic activities separating CO_2 from the atmosphere and storing it durably in geological, land or ocean reservoirs, or in products.
Combined Heat and Power (CHP)	An electricity generating plant combined with equipment to recover and use heat.
Carbon Dioxide Equivalent (CO_2e)	Amount of greenhouse gas, converted in terms of global warming potential over 100 years.
European Economic Area (EEA)	An international agreement which extends the application of the European Union's single market to some member states of the European Free Trade Association (Norway, Iceland, Liechtenstein).
Enhanced Hydrocarbon Recovery (EHR)	Practice of recovering hydrocarbons additional to those produced naturally by injecting gas such as CO_2 or water.
Emissions trading	Market-based mechanism that allows entities to buy and sell permits that authorize them to emit a certain amount of greenhouse gases, such as carbon dioxide (CO_2), into the atmosphere.
Geological Storage	The storage of carbon dioxide in underground geologic formations.
Greenhouse Gas, (GHG)	Group of chemical compounds, including carbon dioxide, methane, and water vapor, that trap heat in the Earth's atmosphere and contribute to the warming of the planet.
Global Warming Potential (GWP)	A measure of how much energy the emission of 1 tonne of a gas will absorb over time compared to the emissions of 1 tonne of CO_2. It is used to estimate the potential future impact of different gases on the climate system.
Integrity Council for the Voluntary Carbon Market (ICVCM)	Independent organization that aims to promote the credibility and transparency of voluntary carbon markets by setting standards, verifying carbon credits, and providing guidance to market participants.

Intergovernmental Panel on Climate Change (IPCC)	Scientific body established by the United Nations to assess the science, risks, and impacts of climate change, and provide policymakers with recommendations for addressing the issue.
Issuance	Act of generating or producing new carbon credits and making them available for purchase in a carbon market.
Leakage	Emissions sources outside of net removals quantification boundaries (see chapter 3 on project boundaries) that increase/decrease as a result of project operations. Four leakage categories are commonly recognised: upstream/downstream emissions, activity-shifting, market leakage and ecological leakage.
Life Cycle Analysis (LCA)	A method to quantify the environmental impacts of a product or service throughout its lifecycle.
Mitigation	reduction or prevention of greenhouse gas emissions and other actions taken to minimize the extent or impact of climate change.
Monitoring, reporting and verification (MRV)	Process of accounting for all the emissions, energy use, environmental and public health impacts associated with a carbon removal project to determine its net climate impact, thereby showing if the work was done safely and effectively.
Partner (business)	Any party involved in upstream and/or downstream BECCS value chain activities that is contracted by the project proponent.
Project Design Document (PDD)	A document that compiles all relevant project data and reflects the project proponent's plan for adherence to the requirements of this methodology.
Project proponent	The project proponent is the party that has the overall control over and responsibility for the BECCS project that generates CDR credits, typically the operator or owner of the carbon capture system.
Primary forest	Naturally regenerated forests of native tree species where there are no clearly visible indications of human activity and the ecological processes are not significantly disturbed.
Project boundary	The project boundary covers all relevant activities leading to carbon sources and sinks that are exclusively initiated by the anticipation of CDR credit revenue from the project.
Registry	Standardized platform for the issuance, trading, and retirement of carbon credits, providing a system for verifying the validity and authenticity of the credits, and for ensuring that they are not double-counted or sold more than once.
Removal credit	Type of carbon credit that is generated by a project or activity that removes carbon dioxide or other greenhouse gases from the atmosphere and can, if it is stored geologically, be used to neutralise emissions.
Reporting	Submission of data and evidence to a third-party organisation (a VVB) for the purpose of independently assuring project outcomes.

Reversal	Any migration of carbon dioxide from its geological reservoirs post injection.
Sustainable Development Goal (SDG)	Set of 17 global goals established by the United Nations to promote sustainable development and address social, economic, and environmental challenges, including poverty, inequality, and climate change.
Sequestration	Process of capturing carbon from the atmosphere and storing it in a way that prevents it from contributing to global warming.
Transport and storage operators	Operators of the carbon dioxide transportation and/or storage facilities, which hold the appropriate licenses and permits to transport, drill and operate injection and monitoring wells.
Validation	Process whereby a validation/verification body (VVB) confirms a project's adherence to all requirements in this methodology. Project validation is a pre-requisite for CDR crediting.
Validation/verification bodies (VVB)	Independent third-party auditors that assess whether a project or program complies with rules or standards.
Verification	The assurance of claims of net CO_2 removal volumes that inform each credit issuance.
Voluntary Carbon Market (VCM)	Platform where organizations and individuals can purchase and sell carbon credits voluntarily to offset their greenhouse gas emissions or support climate change mitigation and adaptation projects.
Zero-rated biomass	Combustion of biomass or biomass-based products in the energy sector is counted as generating zero emissions of carbon dioxide, because net carbon dioxide emissions resulting from changes in biomass carbon stocks are already accounted for by the Agriculture, Forestry and Land Use (AFOLU) sector. This accounting principle was introduced by the IPCC to avoid double counting of emissions.