TOOL FOR DIFFERENTIATING REDUCTIONS AND REMOVALS IN CCS PROJECTS

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1 SOURCES

This tool is used in combination with the most recent version of the following methodologies, modules, and tools:

- *VM00XX Methodology for Carbon Capture and Storage*

Capture Modules

- *VMD00XX Module for CO_2 Capture from Air (Direct Air Capture)*
- *VMD00XX Module for CO_2 Capture from Bioenergy Combustion*
- *VMD00XX Module for CO_2 Capture from Bioproduction Processes*
- *VMD00XX Module for CO_2 Capture from Post combustion Flue Gases in Fossil Fuel Power and Heat Generation*
- *VMD00XX Module for CO_2 Capture from Industrial Processes*
- *VMD00XX Module for CO_2 Capture from Oil and Gas Production and Processing*
- *VMD00XX Module for CO_2 Capture from Precombustion Processes in Fossil Fuel Power and Heat Generation*
- *VMD00XX Module for CO_2 Capture from Oxyfuel Combustion in Fossil Fuel Power and Heat Generation*

Transport Module

- *VMD00XX Module for CO_2 Transport*

Storage Modules

- *VMD00XX Module for CO_2 Storage in Saline Aquifers and Depleted Hydrocarbon Reservoirs*

Other Modules/Tools

- *VT00XX Tool for Non-VCS CO_2 in Carbon Capture and Storage Projects*
- *Geologic Carbon Storage (GCS) Non-Permanence Risk Tool*

VCS Program Requirements/Tool(s):

- *GCS Requirements*

2 SUMMARY DESCRIPTION OF THE TOOL

This tool calculates GHG emission reductions (“reductions”) and carbon dioxide removals (“removals”) from eligible project activities under the most recent version of *VM00XX Methodology for Carbon Capture and Storage* and associated modules.

This tool establishes principles and provides procedures for differentiating baseline emissions and allocating project and leakage emissions among activities that result in GHG emission reductions and carbon dioxide removals.

3 DEFINITIONS

In addition to the definitions set out in the *VCS Program Definitions* and *VM00XX Methodology for Carbon Capture and Storage*, the following definitions apply to this tool.

Anaerobic digestion
The microbial breakdown of organic material in the absence of oxygen. Organic compounds emitted during anaerobic decomposition are mainly methane (CH_4) and lesser amounts of carbon dioxide (CO_2).

Alcoholic Fermentation
A chemical process used in bio-ethanol production in which sugars are converted into ethyl alcohol and CO_2 in the presence of microorganisms.

High ILUC-risk biomass
Biomass that is determined to have high indirect land-use change (ILUC) according to the criteria in Article 3 of the Delegated Regulation on indirect land-use change ((EU) 2019/807)[1]. High ILUC-risk biomass is ineligible to generate either removals or reductions.

Ineligible biomass
Biomass feedstocks that meet the definition of high ILUC risk biomass, do not fall into an acceptable biomass category as defined in Appendix 1, or that cannot meet cascading use and LULUCF criteria.

Non-traceable biomass
Biomass feedstocks that do not meet the definition of “sustainable biomass” due to a failure to meet the traceability requirements outlined in Appendix 2.

[1] Article 3 - Commission Delegated Regulation (EU) 2019/807 of 13 March 2019 supplementing Directive (EU) 2018/2001 of the European Parliament and of the Council as regards the determination of high indirect land-use change-risk feedstock for which a significant expansion of the production area into land with high carbon stock is observed and the certification of low indirect land-use change-risk biofuels, bioliquids and biomass fuels

Sustainable biomass
Biomass feedstocks that meet the sustainability principles and traceability requirements outlined in Appendix 2.

4 APPLICABILITY CONDITIONS

This tool applies to project activities that are eligible under *VM00XX Methodology for Carbon Capture and Storage* and result in both GHG emission reductions and carbon dioxide removals.

This tool does not apply to project activities that;

1. Achieve only CO_2 reductions or only carbon dioxide removals, or
2. Use ineligible biomass.

5 PROCEDURES

This section outlines the procedure for determining the separation of captured CO_2 into reductions and removals and allocating project and leakage emissions to each.

5.1 Categorizing Captured CO_2

Capture activities eligible for removals include DAC and the capture of CO_2 from bioenergy pathways that use sustainable biomass as a fuel source directly or that convert sustainable biomass into a gaseous or liquid fuel through alcoholic fermentation, digestion, pyrolysis, or gasification (BECCS).

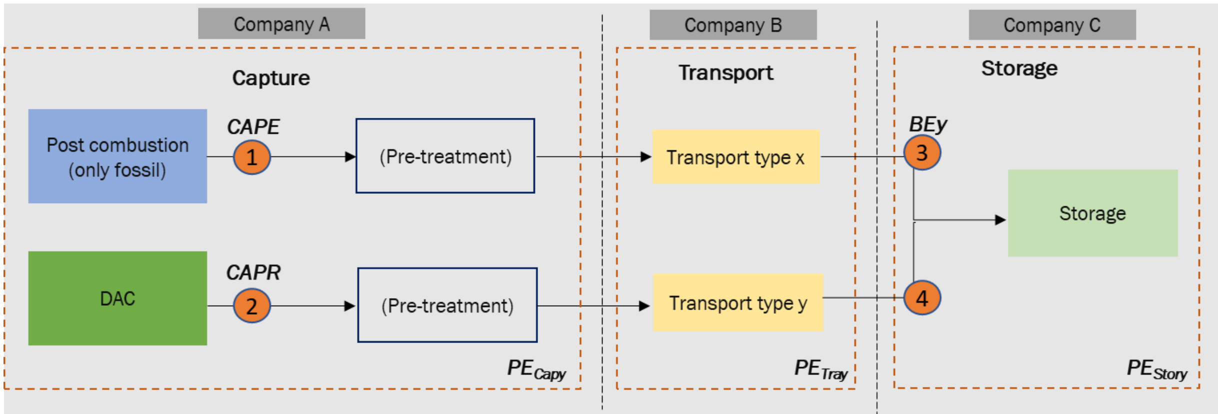
CO_2 captured from the combustion of non-traceable biomass, the non-biogenic fraction of waste, and fossil fuels must be accounted for as emission reductions.

Proponents must classify captured CO_2 as either emission reductions ($CAPE_{c,y}$) or emission removals ($CAPR_{c,y}$) depending on the feedstock/source of the CO_2 and as described in the following two scenarios.

5.1.1 Scenario 1: Single Feedstocks

In this scenario, each capture facility has a single CO_2 source or feedstocks that can categorically be assigned to either emission reductions ($CAPE_{c,y}$) or emission removals ($CAPR_{c,y}$). Figure 1 illustrates an example.

Figure 1: Differentiation between Emissions Reduction and Removal for Multiple Sources, Each with a Single Feedstock Type



Equation (1) categorizes the quantity of CO_2 captured as either a reduction or removal for each capture facility under Scenario 1.

$$CAPE_{c,y} \text{ or } CAPR_{c,y} = Q_{CO2,c,y} \tag{1}$$

Where:

$CAPE_{c,y}$	=	Carbon dioxide captured by capture facility *c* in year *y* that is eligible to be accounted for as an emissions reduction (t CO_2)
$CAPR_{c,y}$	=	Carbon dioxide captured by capture facility *c* in year *y* that is eligible to be accounted for as a removal (t CO_2)
$Q_{CO2,c,y}$	=	Total carbon dioxide captured by capture facility *c* in year *y* (t CO_2)

5.1.2 Scenario 2: Mixed Feedstocks

In this scenario, the captured CO_2 cannot be categorized directly as reductions or removals. Figure 2 and Figure 3 illustrate scenarios where captured emissions are derived from mixed feedstocks from a single source and multiple sources, respectively.

Figure 2: Differentiation between Emission Reduction and Removal with Mixed Feedstocks from a Single Source

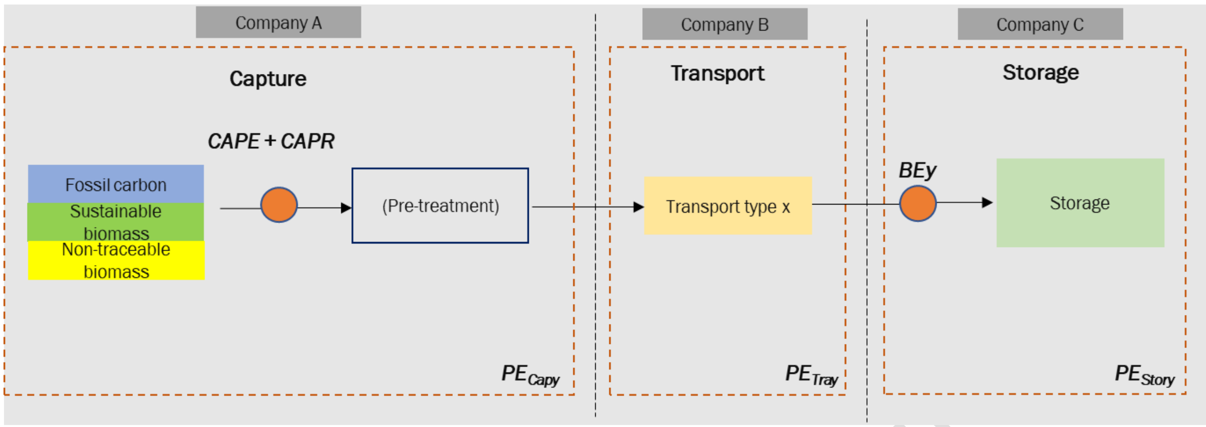
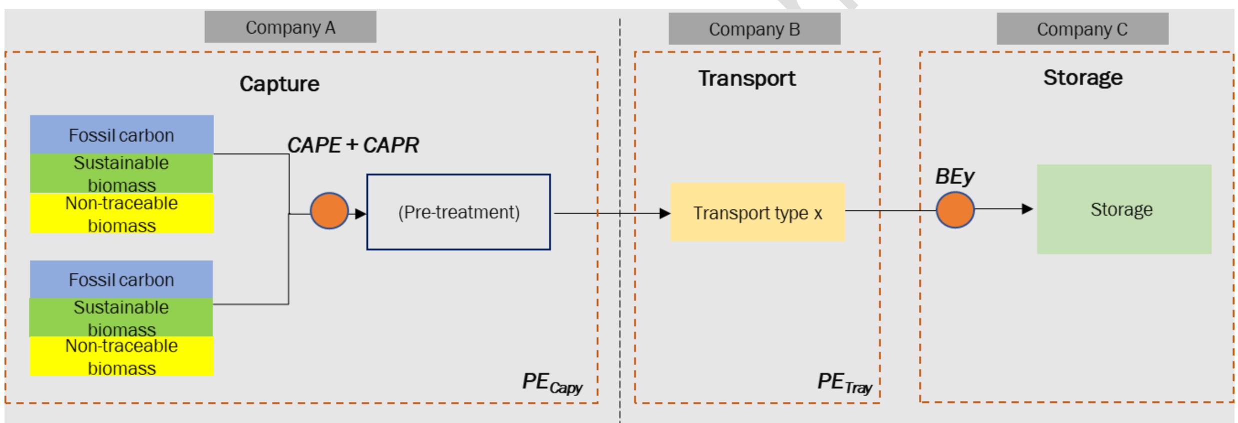


Figure 3: Differentiation between Emission Reduction and Removal with Mixed Feedstocks from Multiple Sources



Equation (2) determines the quantity of CO_2 captured that qualifies as removals for each capture facility under Scenario 2.

$$CAPR_{c,y} = Q_{CO2,c,y} \times f_{rem-CO2,c,y} \tag{2}$$

Where:

$CAPR_{c,y}$	=	Carbon dioxide captured by capture facility c in year y that is eligible to be accounted for as a removal (t CO_2)
$Q_{CO2,c,y}$	=	Total carbon dioxide captured by capture facility *c* in year *y* (t CO_2)
$f_{rem\text{-}CO2,c,y}$	=	Fraction of CO_2 stream from capture facility *c* eligible for removals in year *y* as calculated in Equation (11) (-)

Equation (*3*) determines the quantity of CO_2 captured that qualifies as an emission reduction for each capture facility under Scenario 2.

$$CAPE_{c,y} = Q_{CO2,c,y} \times f_{red-CO2,c,y} \tag{3}$$

Where:

$CAPE_{c,y}$	=	Carbon dioxide captured by capture facility *c* in year *y* that is eligible to be accounted for as an emissions reduction (t CO_2)
$Q_{CO2,c,y}$	=	Total carbon dioxide captured by capture facility *c* in year *y* (t CO_2)
$f_{red-CO2,c,y}$	=	Fraction of CO_2 stream from capture facility *c* eligible for reductions in year *y* as calculated in Equation (5).(-)

5.1.3 Determining Total CO_2 Captured

Equation (4) calculates the total amount of CO_2 captured as reductions and removals by the project each year and applies to both Scenarios 1 and 2.

$$TCAP_y = \sum_c CAPE_{c,y} + \sum_c CAPR_{c,y} \tag{4}$$

Where:

$TCAP_y$	=	Total amount of CO_2 captured by the project in year *y* (t CO_2)
$CAPE_{c,y}$	=	Carbon dioxide captured by capture facility *c* in year *y* that is eligible to be accounted for as an emissions reduction (t CO_2)
$CAPR_{c,y}$	=	Carbon dioxide captured by capture facility *c* in year *y* that is eligible to be accounted for as a removal (t CO_2)

5.2 Determining the Fraction of Removals in a CO_2 Stream

This section outlines the procedures for determining the portion of a captured CO_2 stream that represents removals ($f_{rem-CO2,c,y}$) depending on whether the biogenic component of the feedstock mix can be quantified.

5.2.1 Using Mass Balance

Proponents must use the mass balance approach when:

1. The quantity of sustainable biomass feedstocks in the feedstock mix is known, and
2. The mixture includes non-traceable biomass.

Proponents must calculate $f_{rem\text{-}CO2,c,y}$ based on the end use of the feedstock as described in Sections 5.2.1.1 and 5.2.1.2.

5.2.1.1 End-Use 1: Bioenergy for Heat and Power

Equation (5) determines the fraction of a CO_2 stream that represents removals ($f_{rem\text{-}CO2,c,y}$) from heat and power generation using sustainable biomass.

$$f_{rem-CO2,c,y} = \frac{\sum_b (m_{sb,b,c,y} \times w_{sb,b,c,y}) \times \frac{44}{12}}{Q_{CO2,c,y}} \quad (5)$$

Where:

$f_{rem\text{-}CO2,c,y}$	=	Fraction of CO_2 stream from capture facility *c* eligible for removals in year *y* (-)
$m_{sb,b,c,y}$	=	Mass of sustainable biomass type *b*, on a dry basis, generating emissions captured by capture facility *c* in year *y* (t)
$w_{sb,b,c,y}$	=	Weighted average mass fraction of carbon in non-traceable biomass type *b* in year *y* on a dry basis, captured by capture facility *c* (t carbon/t biomass feedstock)
$Q_{CO2,c,y}$	=	Total carbon dioxide captured by capture facility *c* in year *y* (t CO_2)

5.2.1.2 End-Use 2: Waste to Energy

Equation (6) determines the fraction of a CO_2 stream that represents removals ($f_{rem\text{-}CO2,c,y}$) from the biogenic component of a waste stream in a waste-to-energy plant.

$$f_{rem-CO2,c,y} = \frac{\sum_b (m_{sb,b,c,y} \times Y_{CO2,b,c,y}) \times \rho_{CO2(STP)}}{Q_{CO2,c,y}} \quad (6)$$

Where:

$f_{rem\text{-}CO2,c,y}$	=	Fraction of CO_2 stream from capture facility *c* eligible for removals in year *y* (-)
$m_{sb,b,c,y}$	=	Mass of sustainable biomass type *b*, on a dry basis, generating emissions captured by capture facility *c* in year *y* (t)
$Y_{CO2,b,y}$	=	CO_2 yield of biomass feedstock *b* in year *y* on a dry basis (i.e., volume of CO_2 generated from one tonne of dry matter of biomass feedstock *b* at capture facility *c* (Nm^3 CO_2/t dry matter)
$\rho_{CO2(STP)}$	=	Density of CO_2 at standard temperature and pressure (STP) (t CO_2/Nm^3)
$Q_{CO2,c,y}$	=	Total carbon dioxide captured by capture facility *c* in year *y* (t CO_2)

Proponents must use the appropriate equation to calculate the CO_2 yield of the biomass feedstock ($Y_{CO2,b,y}$) based on the method of energy production, as follows.

Anaerobic Digestion, Gasification or Pyrolysis

$$Y_{CO2,b,y} = VS_{b,y} \times Y_{BG,b,y} \times \%CO2_{vol(STP)} \times \eta_{sep} \tag{7}$$

Where:

$Y_{CO2,b,y}$	=	CO_2 yield of biomass feedstock *b* in year *y* on a dry basis (i.e., volume of CO_2 generated from one tonne of dry matter of biomass feedstock *b* at capture facility *c* (Nm^3 CO_2/t)
$VS_{b,y}$	=	Volatile solids content, on a dry basis, in biomass feedstock *b* in year *y* (t volatile contents/t dry matter)
$Y_{BG,b,y}$	=	Volume of biogas/syngas produced from one tonne of volatile solids in biomass feedstock *b,* on a dry basis, in year *y* (Nm^3 biogas/syngas/t volatile solids)
$\%CO2_{vol(STP)}$	=	Volumetric CO_2 fraction in gas flow at STP conditions (% volume)
η_{sep}	=	The efficiency of separation of CO2 from other gases in total gas yield (-)

Aerobic Digestion[2]

$$Y_{CO2,b,y} = VS_{b,y} \times Y_{G,b,y} \times \eta_{sep} \tag{8}$$

Where:

$Y_{CO2,b,y}$	=	CO_2 yield of biomass feedstock *b* in year *y* on a dry basis (i.e., volume of CO_2 generated from one tonne of dry matter of biomass feedstock *b* at capture facility *c* (Nm^3 CO_2/t dry matter)
$VS_{b,y}$	=	Volatile solids content, on a dry basis, in biomass feedstock *b* in year *y* (t volatile solids/t dry matter)
$Y_{G,b,y}$	=	Volume of CO_2 produced from one tonne of volatile solids in biomass feedstock *b,* on a dry basis, in year *y* (Nm^3 CO_2/t volatile solids)
η_{sep}	=	The efficiency of separation of CO2 from other gases in total gas yield (-)

Alcoholic Fermentation (Ethanol production)

$$Y_{CO2,b,y} = Y_{BE,b,y} \times CO2_{vol,BE(STP)} \tag{9}$$

[2] For the aerobic digestion process, the amount of CO_2 produced is directly proportional to the volatile solids being digested. Methane is not produced during aerobic digestion. Therefore, $Y_{CO2,b,y}$ is the total CO_2 yield from the volatile solids.

Where:

$Y_{CO2,b,y}$	=	CO_2 yield of ethanol production from biomass feedstock *b* in year *y* on a dry basis (i.e., volume of CO_2 generated from one tonne of dry matter of biomass feedstock *b* at capture facility *c* (Nm^3 CO_2/t dry matter)
$Y_{BE,b,y}$	=	Ethanol yield of biomass feedstock *b*, on a dry basis, in year *y* (i.e., mass or volume unit of ethanol produced from one tonne of dry matter of biomass feedstock *b*) (L ethanol/t feedstock)
$CO2_{vol,BE(STP)}$	=	CO_2 content relative to ethanol at STP conditions (m^3/L ethanol)

$$CO2_{vol,BE(STP)} = \frac{FR_{vol(STP)} \times \%CO2_{vol(STP)}}{Q_{ethanol,y}} \tag{10}$$

Where:

$CO2_{vol,BE(STP)}$	=	CO_2 content relative to ethanol at STP conditions (m^3/L ethanol)
$FR_{vol(STP)}$	=	Volumetric flow rate of gas emitted during ethanol production, measured at actual conditions and converted to STP conditions (m^3)
$\%CO2_{vol(STP)}$	=	Volumetric CO_2 fraction in gas flow at STP conditions (% volume)
$Q_{ethanol,y}$	=	Ethanol produced by project activity plant in year *y* (L)

5.2.2 Using Emission Source Analysis

This approach is only permissible when:

1. The proportion of biogenic and fossil fuel feedstocks in a mixture is not known, and
2. The biogenic component of the mixture is entirely from sustainable biomass.

Proponents must use one of the following methods to determine $f_{rem\text{-}CO2,c,y}$ as the biogenic component of the mixture.

a) *ISO 13833:2013 Stationary source emissions – Determination of the ratio of biomass (biogenic) and fossil-derived carbon dioxide – Radiocarbon sampling and determination*; or

b) *ISO 18466:2016 Stationary source emissions – Determination of the biogenic fraction in CO2 in stack gas using the balance method*.

5.3 Determining the Fraction of Reductions in a CO_2 Stream

Equation (11) determines the fraction of reductions in a CO_2 stream.

$$f_{red-CO2,c,y} = \left(1 - f_{rem-CO2,c,y}\right) \tag{11}$$

Where:

$f_{rem\text{-}CO2,c,y}$	=	Fraction of CO_2 stream from capture facility *c* eligible for removals in year *y* (-)
$f_{red\text{-}CO2,c,y}$	=	Fraction of CO_2 stream from capture facility *c* eligible for reductions in year *y* (-)

5.4 Allocation of Baseline Emissions to Reductions and Removals

5.4.1 Allocation to Removals

Equation (12) determines the amount of baseline emissions allocated to removals.

$$BE_{CAPR,y} = BE_y \times \frac{\sum_c CAPR_{c,y}}{TCAP_y} \tag{12}$$

Where:

$BE_{CAPR,y}$	=	Baseline emissions associated with removals in year *y* (t CO_2)
BE_y	=	Baseline emissions as determined by Section 8.1 of *VM00XX Methodology for Carbon Capture and Storage* (t CO_2)
$CAPR_{c,y}$	=	Carbon dioxide captured by capture facility *c* in year *y* that is eligible to be accounted for as a removal (t CO_2)
$TCAP_y$	=	Total amount of CO_2 captured by the project in year *y* (t CO_2)

5.4.2 Allocation to Reductions

Equation (13) determines the amount of baseline emissions allocated to reductions.

$$BE_{CAPE,y} = \left(BE_y \times \frac{\sum_c CAPE_{c,y}}{TCAP_y}\right) - \sum_c RD_{c,y} \tag{13}$$

Where:

$BE_{CAPE,y}$	=	Baseline emissions associated with reductions in year *y* (t CO_2)
BE_y	=	Baseline emissions as determined by Section 8.1 of *VM00XX Methodology for Carbon Capture and Storage* (t CO_2)
$CAPE_{c,y}$	=	Carbon dioxide captured by capture facility *c* in year *y* that is eligible to be accounted for as an emissions reduction (t CO_2)
$TCAP_y$	=	Total amount of CO_2 captured by the project in year *y* (t CO_2)

$RD_{c,y}$ = Reduction discount factor for exceeding the non-traceable biomass limit in year *y* at capture facility *c* as determined in Equation (14); for projects without non-traceable biomass, $RD_{c,y}$ = 0 (t CO_2e)

5.4.2.1 Discount for Non-Traceable Biomass

The discount factor incentivizes proponents to move away from using non-traceable biomass over time. No more than 30 percent of the total biomass used may be non-traceable biomass in the first year of a project. Projects must reduce non-traceable biomass use by 10 percent each subsequent project year compared to the previous year to avoid discounted reductions.

No credit can be generated from non-traceable biomass after the first crediting period.

Equation (14) determines the captured emissions from non-traceable biomass discounted from total facility reductions.

$$RD_{c,y} = \sum_{b} (m_{A\_nt,b,c,y} \times w_{nt,b,c,y}) \times \frac{44}{12} \tag{14}$$

Where:

$RD_{c,y}$ = Reduction discount factor for exceeding the non-traceable biomass limit in year *y* at capture facility *c;* for projects without non-traceable biomass, $RD_{c,y}$ = 0 (t CO_2e)

$m_{A\_nt,b,c,y}$ = Adjusted quantity of non-traceable biomass type *b*, on a dry basis, generating emissions captured at capture facility *c* in year *y* (t)

$w_{nt,b,c,y}$ = Weighted average mass fraction of carbon in non-traceable biomass type *b*, on a dry basis, generating emissions captured by capture facility *c* in year *y* (t carbon/t biomass feedstock)

Equation (15) determines the adjusted quantity of the non-traceable biomass generating emissions at a capture facility.

$$m_{A\_nt,b,c,y} = [m_{nt,b,c,y} - \min\ (m_{nt,b,c,y}\ ,\ (m_{BV,b,c} \times (1 - 0.1)^{n}))] \tag{15}$$

Where:

$m_{A\_nt,b,c,y}$ = Adjusted quantity of non-traceable biomass type *b*, on a dry basis, generating emissions captured at capture facility *c* in year *y* (t)

$m_{nt,b,c,y}$ = Mass of non-traceable biomass type *b*, on a dry basis, generating emissions captured by capture facility *c* in year *y* (t)

$m_{BV,b,c}$ = Base value for non-traceable biomass type *b*, on a dry basis, generating emissions captured by capture facility *c*, as calculated in Equation (16) (t)

0.1 = Default annual adjustment factor

n	=	Number of years since project start date

Determination of Base Value ($m_{BV,b,c}$)

The base value represents the average consumption of non-traceable biomass *b* during the last three years before the earlier of the project activity start date or validation date or the actual operational period where the project has been operating for less than three years[3] Equation (16) determines the base value for non-traceable biomass.

$$m_{BV,b,c} = \min\left(m_{AV\_nt,b,c}, 0.3 \times \sum_{c}(m_{AV,T,c})\right) \tag{16}$$

Where:

$m_{BV,b,c}$	=	Base value for non-traceable biomass type *b*, on a dry basis, generating emissions captured by capture facility *c* (t)
$m_{AV\_nt,b,c}$	=	Average mass of non-traceable biomass *b*, on a dry basis, consumed during the three-year or actual operating period at capture facility *c* (t)
0.3	=	Limit on non-traceable biomass use
$m_{AV,T,c}$	=	Average total biomass consumption, on a dry basis, in the pre-project activity (t)

5.5 Allocation of Project and Leakage Emissions to Removals and Reductions

Proponents must choose one or a combination of the following options to allocate corresponding project and leakage emissions by segment within the project boundary.

5.5.1 Option 1: Differentiation Method

This method is permissible for segments where captured CO_2 can be categorized as reductions or removals based on equipment or temporal differentiation. Equipment differentiation means that equipment involved in the processing of captured CO_2 has individual metering and the resulting emissions can be directly attributed to each CO_2 stream. Temporal differentiation means captured CO_2 streams flow at different times and equipment meters have a time resolution sufficient to resolve and attribute the emissions from each period accordingly.

[3] Alternatively, regional or sector-specific benchmarks may be used to establish a limit for non-traceable biomass consumption from similar projects. In both cases, choose the minimum value derived from these methods to ensure a conservative approach.

Equations (17), (18), (19) and (20), assign the differentiated portion of project and leakage emissions to either removals or reductions.

$$PE_{CAPR,x,y} = \sum_{D} PE_{CAPR,x,y,D} \tag{17}$$

$$LE_{CAPR,x,y} = \sum_{D} LE_{CAPR,x,y,D} \tag{18}$$

$$PE_{CAPE,x,y} = \sum_{D} PE_{CAPE,x,y,D} \tag{19}$$

$$LE_{CAPE,x,y} = \sum_{D} LE_{CAPE,x,y,D} \tag{20}$$

Where:

$PE_{CAPR,x,y}$	=	Project emissions from segment *x* in year *y* associated with emission removals (t CO_2)
$PE_{CAPR,x,y,D}$	=	Project emissions from segment *x* in differentiated equipment *D* or with temporal differentiation *D* associated with emission removals in year *y* (t CO_2)
$LE_{CAPR,x,y}$	=	Leakage emissions from segment *x* in year *y* associated with emission removals (t CO_2)
$LE_{CAPR,x,y,D}$	=	Leakage emissions from segment *x* in differentiated equipment *D* or with temporal differentiation *D* associated with emission removals in year *y* (t CO_2)
$PE_{CAPE,x,y}$	=	Project emissions from segment *x* in year *y* associated with emission reductions (t CO_2)
$PE_{CAPE,x,y,D}$	=	Project emissions from segment *x* in differentiated equipment *D* or with temporal differentiation *D* associated with emission reductions in year *y* (t CO_2)
$LE_{CAPE,x,y}$	=	Leakage emissions from segment *x* in year *y* associated with emission reductions (t CO_2)
$LE_{CAPE,x,y,D}$	=	Leakage emissions from segment *x* in differentiated equipment *D* or with temporal differentiation *D* associated with emission reductions in year *y* (t CO_2)

5.5.2 Option 2: Mass Balance

This method is permissible for segments where the flows of removals and reductions follow the same pathway within the project boundary (i.e., travel modes and distances are equal, and all facilities are shared).

Equations (21) and (22) allocate project and leakage emissions, respectively, from a segment to emission removals.

$$PE_{CAPR,x,y} = PE_{total,x,y} \times f_{rem-CO2,c,y} \tag{21}$$

$$LE_{CAPR,x,y} = LE_{total,x,y} \times f_{rem-CO2,c,y} \tag{22}$$

Where:

$PE_{CAPR,x,y}$	=	Project emissions from segment *x* in year *y* associated with emission removals (t CO_2)
$PE_{total,x,y}$	=	Total project emissions generated from segment *x* in the value chain of project activity in year y, calculated as per Equation (7) in the most recent version of *VM00XX Methodology for Carbon Capture and Storage* (t CO_2)
$LE_{CAPR,x,y}$	=	Leakage emissions from segment *x* in year *y* associated with emission removals (t CO_2)
$LE_{total,x,y}$	=	Total leakage emissions generated from segment *x* in year *y*, calculated as per Equation (8) in the most recent version of *VM00XX Methodology for Carbon Capture and Storage* (t CO_2)
$f_{rem-CO2,c,y}$	=	Fraction of CO_2 stream from capture facility *c* eligible for removals in year *y* (-)

Equations (23) and (24) allocate project and leakage emissions, respectively, from a segment based on the fraction of the CO_2 stream that qualifies as emission reductions.

$$PE_{CAPE,x,y} = PE_{total,x,y} \times f_{red-CO2,c,y} \tag{23}$$

$$LE_{CAPE,x,y} = LE_{total,x,y} \times f_{red-CO2,c,y} \tag{24}$$

Where:

$PE_{CAPE,x,y}$	=	Project emissions from segment *x* in year *y* associated with emission reductions (t CO_2)
$PE_{total,x,y}$	=	Total project emissions generated from segment *x* in the value chain of project activity in year *y*, calculated as per Equation (7) in the most recent version of *VM00XX Methodology for Carbon Capture and Storage* (t CO_2)
$LE_{CAPE,x,y}$	=	Leakage emissions from segment *x* in year *y* associated with emission reductions (t CO_2)
$LE_{total,x,y}$	=	Total leakage emissions generated from segment *x* in year *y*, calculated as per Equation (8) in the most recent version of *VM00XX Methodology for Carbon Capture and Storage* (t CO_2)

$f_{red\text{-}CO2,c,y}$	=	Fraction of CO_2 stream from capture facility *c* eligible for reductions in year *y* (-)

5.6 Emission Removals and Reductions

Equations (25) and (26) calculate the total project emission removals and reductions, respectively.

$$CR_y = BE_{CAPR,y} - \sum_x PE_{CAPR,x,y} - \sum_x LE_{CAPR,x,y} \quad (25)$$

$$ER_y = BE_{CAPE,y} - \sum_x PE_{CAPE,x,y} - \sum_x LE_{CAPE,x,y} \quad (26)$$

Where:

CR_y	=	Emissions removals in year *y* (t CO_2e)
$BE_{CAPR,y}$	=	Baseline emissions associated with removals in year *y* as calculated in Equation (12) (t CO_2)
$PE_{CAPR,x,y}$	=	Project emissions from segment *x* in year *y* associated with emission removals as calculated in Equation (21) (t CO_2)
$LE_{CAPR,x,y}$	=	Leakage emissions from segment *x* in year *y* associated with emission removals as calculated in Equation (22) (t CO_2)
ER_y	=	Emissions reductions in year *y* (t CO_2e)
$BE_{CAPE,y}$	=	Baseline emissions associated with reductions in year *y* as calculated in Equation (13) (t CO_2)
$PE_{CAPE,x,y}$	=	Project emissions from segment *x* in year *y* associated with emission reductions as calculated in Equation (23) (t CO_2)
$LE_{CAPE,x,y}$	=	Leakage emissions from segment *x* in year *y* associated with emission reductions as calculated in Equation (24) (t CO_2)

6 DATA AND PARAMETERS

6.1 Data and Parameters Available at Validation

Data/Parameter	$\rho_{CO2(STP)}$
Data unit	t CO_2/Nm^3
Description	Density of CO_2 at standard temperature and pressure (STP)
Equations	(6)

Source of data	Internationally accepted data sets, e.g., Span and Wagner (for further information, see National Institute of Standards and Technology, available at https://webbook.nist.gov/chemistry/fluid/ or similar).
Value applied	N/A
Justification of choice of data or description of measurement methods and procedures applied	Density depends on temperature and pressure as defined under STP conditions used as per industry practice in the geological location of the project.
Purpose of data	Calculation of baseline and project emissions
Comments	N/A

Data/Parameter	$m_{AV\_nt,b,c}$
Data unit	t
Description	Average amount of non-traceable biomass *b*, on a dry basis, consumed during the three years immediately prior to the start date of the project activity or over the actual operating period at capture facility c.
Equations	(16)
Source of data	On-site measurement
Value applied	Measured from belt weigher/weigh bridge, calculated from receipts and invoices or publicly available official data
Justification of choice of data or description of measurement methods and procedures applied	Average non-traceable biomass consumption is calculated as the average annual non-traceable biomass consumption during the three years immediately preceding the start date of the project activity. Where a project has been operational for less than three years, the average consumption of non-traceable biomass must be calculated over the actual operational period. In the absence of actual consumption data, the minimum value derived from regional or sector-specific benchmarks may be used to establish a limit for non-traceable biomass consumption by researching and analyzing similar projects within the region or sector.
Purpose of data	Calculation of the base value on a dry basis for non-traceable biomass type *b* generating emissions captured by capture facility *c*
Comments	N/A

Data/Parameter	$m_{AV,T,c}$
Data unit	t

Description	Average total biomass consumption, on a dry basis, in the pre-project activity
Equations	(16)
Source of data	On-site measurement
Value applied	Measured from belt weigher/weigh bridge or calculated from receipts/invoices
Justification of choice of data or description of measurement methods and procedures applied	Average total biomass consumption is calculated as the average annual total biomass consumption during the three years immediately preceding the start date of the project activity. Where a project has been operational for less than three years, the average consumption of total biomass may be calculated over the actual operational period.
Purpose of data	Calculation of the base value on a dry basis for non-traceable biomass type *b* generating emissions captured by capture facility *c*
Comments	N/A

Data/Parameter	η_{sep}
Data unit	Dimensionless
Description	The efficiency of separation of CO2 from other gases in total gas yield
Equations	(7), (8)
Source of data	Derived from process design or operational data, industry benchmarks, or experimental results. For further information, consult relevant technical literature on gas separation technologies and efficiency assessments.
Value applied	N/A
Justification of choice of data or description of measurement methods and procedures applied	*Separation efficiency is determined based on the specific technology used for CO2 capture and separation, operational conditions, and gas composition. It can be obtained from manufacturer specifications, pilot plant data, or through calculation based on gas properties and separation technology performance.*
Purpose of data	Calculation of baseline and project emissions
Comments	N/A

6.2 Data and Parameters Monitored

Data/Parameter	$Q_{CO2,c,y}$
Data unit	t CO_2

Description	Total CO_2 captured at capture facility *c* in year *y*
Equations	(1), (3), (5), (6)
Source of data	Calculated as per Section 8.1 of *VM00XX Methodology for Carbon Capture and Storage*
Description of measurement methods and procedures to be applied	As per Section 8.1 of *VM00XX Methodology for Carbon Capture and Storage*
Frequency of monitoring/recording	As per Section 8.1 of *VM00XX Methodology for Carbon Capture and Storage*
QA/QC procedures to be applied	As per Section 8.1 of *VM00XX Methodology for Carbon Capture and Storage*
Purpose of data	Allocation of baseline project and leakage emissions for emission reductions and removals
Calculation method	Calculated as per Section 8.1 of *VM00XX Methodology for Carbon Capture and Storage*
Comments	

Data/Parameter	$m_{sb,b,c,y}$
Data unit	t CO_2
Description	Mass of sustainable biomass type *b*, on a dry basis, generating emissions captured by capture facility *c* in year *y* (t)
Equations	(5), (6), (15)
Source of data	Feedstock receipts or meter readings
Description of measurement methods and procedures to be applied	Measured from belt weigher/weigh bridge or calculated from receipts/invoices
Frequency of monitoring/recording	Aggregated annually
QA/QC procedures to be applied	Meters must be operated within the manufacturer's specified operating conditions. Flow meters must be routinely calibrated, inspected and maintained according to the manufacturer's specifications.
Purpose of data	Calculation and differentiation of emissions associated with reductions and removals for mixed feedstocks
Calculation method	Load cells measure feedstock weight on the belt and send a signal to the integrator, which receives the input in the form of electrical pulses from a belt speed sensor. From the data sources of weight and speed, the mass rate of feedstock is calculated and the total mass of feedstock in the whole year is obtained.

Comments	

Data/Parameter	$w_{sb,b,c,y}$
Data unit	t carbon/t biomass feedstock
Description	Weighted average mass fraction of carbon in sustainable biomass type *b*, on a dry basis, captured by capture facility *c*
Equations	(5), (14)
Source of data	Values provided by the feedstock supplier in invoices are the preferred data source. Where these are unavailable, values may be sourced through measurement by the project proponent or operator of the source facility.
Description of measurement methods and procedures to be applied	Measurements must be carried out at accredited laboratories according to relevant international standards.
Frequency of monitoring/recording	The mass fraction of carbon should be obtained for each feedstock delivery.
QA/QC procedures to be applied	Verify whether the values are within the uncertainty range of the product of the IPCC default values as provided in Tables 1.2 and 1.3, Vol. 2 of the *2006 IPCC Guidelines*. Where the values fall below this range, collect additional information from the testing laboratory to justify the outcome or conduct additional measurements. The laboratories used for measurements by project participants should have ISO 17025 accreditation.
Purpose of data	
Calculation method	Weighted average annual values should be calculated for each feedstock delivery.
Comments	

Data/Parameter	$f_{rem\text{-}CO2,c,y}$
Data unit	Dimensionless
Description	Fraction of CO_2 stream from capture facility *c* eligible for removals in year *y*
Equations	(3), (5), (6), (11), (23), (24)
Source of data	On-site measurement
Description of measurement methods and procedures to be applied	Where the waste can be sorted into pure biogenic and fossil, the project proponent may: a) Implement procedures in Section 5.1.1 to determine the fossil content of the feedstock.

	Where the waste contains mixed samples (not recognizable as biogenic or fossil matter), the project proponent must apply one of the options in Section 5.2.2: b) Techniques employing radiocarbon analyses of samples obtained continuously from CO_2 stream gas, applying *ISO 13833 Stationary source emissions – Determination of the ratio of biomass (biogenic) and fossil-derived carbon dioxide – Radiocarbon sampling and determination.* c) The balance method, as delineated in *ISO 18466 Stationary source emissions – Determination of the biogenic fraction in CO2 in stack gas using the balance method.*
Frequency of monitoring/recording	For each feedstock delivery
QA/QC procedures to be applied	**Option a:** Flow or weight meters must be operated within the manufacturer's specified operating conditions, and must be routinely calibrated, inspected and maintained according to the manufacturer's specifications. Measurements must be adjusted for moisture content to determine the quantity of dry biomass. **Option b:** Measurement must follow the QA/QC procedures defined in ISO 13833. **Option c:** Measurements must follow the QA/QC procedures defined in ISO 18466.
Purpose of data	Calculation and differentiation of emissions associated with reductions and removals for mixed feedstocks
Calculation method	N/A
Comments	

Data/Parameter	$f_{red\text{-}CO2,c,y}$
Data unit	Dimensionless
Description	Fraction of CO_2 stream from capture facility *c* eligible for removals in year *y*
Equations	(11), (23), (24)
Source of data	Calculated
Description of measurement methods and procedures to be applied	Section
Frequency of monitoring/recording	For each feedstock delivery
QA/QC procedures to be applied	N/A
Purpose of data	Calculation and differentiation of emissions associated with reductions and removals for mixed feedstocks

Calculation method	Section 5.3
Comments	

Data/Parameter	$m_{A\_nt,b,c,y}$
Data unit	t
Description	Adjusted quantity of non-traceable biomass type *b*, on a dry basis, generating emissions captured at capture facility *c* in year *y*
Equations	(14), (15)
Source of data	Calculated from Equation (15)
Description of measurement methods and procedures to be applied	Calculated from Equation (15)
Frequency of monitoring/recording	Aggregated annually
QA/QC procedures to be applied	N/A
Purpose of data	Calculation of reduction discount factor for non-traceable biomass
Calculation method	Calculated from Equation (15)
Comments	N/A

Data/Parameter	$VS_{b,y}$
Data unit	t volatile content/t dry matter of biomass feedstock
Description	Volatile solids content, on a dry basis, in biomass feedstock *b* in year *y*
Equations	(7), (8)
Source of data	Values provided by the feedstock supplier in invoices are the preferred data source. Where these are unavailable, values may be sourced through measurement.
Description of measurement methods and procedures to be applied	Measurement of the weight percentage of gas from sampling tests
Frequency of monitoring/recording	Average annual values should be calculated from the metered value for each feedstock delivery.
QA/QC procedures to be applied	Measurements must take place at accredited laboratories according to relevant international standards.

Purpose of data	Calculation and differentiation of emissions associated with reductions and removals in mixed feedstocks
Calculation method	Weighted average annual values should be calculated from the metered value for each feedstock delivery.
Comments	

Data/Parameter	$Y_{BG,b,y}$
Data unit	Nm^3 biogas/t volatile content Nm^3 syngas/t volatile content
Description	Volume of biogas/syngas produced from one tonne of volatile solids in biomass feedstock *b,* on a dry basis, in year *y* (Nm^3 biogas/syngas/t volatile solids)
Equations	(7)
Source of data	On-site measurements
Description of measurement methods and procedures to be applied	Estimated based on empirical data or calculated using models
Frequency of monitoring/recording	Average annual values should be calculated from the metered value for each feedstock delivery.
QA/QC procedures to be applied	Measurements must take place at accredited laboratories according to relevant international standards.
Purpose of data	Calculation and differentiation of emissions associated with reductions and removals for mixed feedstocks
Calculation method	Estimated based on empirical data or calculated using models
Comments	

Data/Parameter	$Y_{G,b,y}$
Data unit	Nm^3 CO_2/t volatile content
Description	Volume of CO_2 produced from one tonne of volatile solids in biomass feedstock *b,* on a dry basis, in year *y* (Nm^3 CO_2/t volatile solids)
Equations	(8)
Source of data	On-site measurements
Description of measurement methods and procedures to be applied	Estimated based on empirical data or calculated using models

Frequency of monitoring/recording	Average annual values should be calculated from the metered value for each feedstock delivery.
QA/QC procedures to be applied	Measurements must take place at accredited laboratories according to relevant international standards.
Purpose of data	Calculation and differentiation of emissions associated with reductions and removals for mixed feedstocks
Calculation method	Estimated based on empirical data or calculated using models
Comments	

Data/Parameter	$Y_{BE,b,y}$
Data unit	L ethanol/t feedstock
Description	Ethanol yield of biomass feedstock *b*, on a dry basis, in year *y* (i.e., mass or volume unit of ethanol produced from one tonne of dry matter of biomass feedstock *b*)
Equations	(9)
Source of data	On-site measurements
Description of measurement methods and procedures to be applied	Estimated based on empirical data or calculated using models
Frequency of monitoring/recording	Average annual values should be calculated from the metered value for each feedstock delivery.
QA/QC procedures to be applied	Measurements must take place at accredited laboratories according to relevant international standards.
Purpose of data	Calculation and differentiation of emissions associated with reductions and removals for mixed feedstocks
Calculation method	Estimated based on empirical data or calculated using models
Comments	

Data/Parameter	$\%CO2_{vol(STP)}$
Data unit	% volume
Description	Volumetric CO_2 fraction in gas flow at STP conditions
Equations	(7), (10)
Source of data	Calculated as per Section 8.1 of *VM00XX Methodology for Carbon Capture and Storage*

Description of measurement methods and procedures to be applied	As per Section 8.1 of *VM00XX Methodology for Carbon Capture and Storage*
Frequency of monitoring/recording	As per Section 8.1 of *VM00XX Methodology for Carbon Capture and Storage*
QA/QC procedures to be applied	As per Section 8.1 of *VM00XX Methodology for Carbon Capture and Storage*
Purpose of data	Calculation and differentiation of emissions associated with reductions and removals in mixed feedstocks
Calculation method	Calculated as per Section 8.1 of *VM00XX Methodology for Carbon Capture and Storage*
Comments	

Data/Parameter	$FR_{vol(STP)}$
Data unit	m^3
Description	Volumetric flow rate of gas emitted during ethanol production, measured at actual conditions and converted to STP conditions
Equations	(10)
Source of data	Calculated as per Section 8.1 of *VM00XX Methodology for Carbon Capture and Storage*
Description of measurement methods and procedures to be applied	As per Section 8.1 of *VM00XX Methodology for Carbon Capture and Storage*
Frequency of monitoring/recording	As per Section 8.1 of *VM00XX Methodology for Carbon Capture and Storage*
QA/QC procedures to be applied	As per Section 8.1 of *VM00XX Methodology for Carbon Capture and Storage*
Purpose of data	Calculation and differentiation of emissions associated with reductions and removals for mixed feedstocks
Calculation method	Calculated as per Section 8.1 of *VM00XX Methodology for Carbon Capture and Storage*
Comments	

Data/Parameter	$Q_{ethanol,y}$
Data unit	Liter
Description	Ethanol produced by project activity plant in year *y*
Equations	(10)

Source of data	On-site measurements
Description of measurement methods and procedures to be applied	Mass flow rates must be determined using commercially available devices that measure the mass flow rate of a fluid flowing through a measurement channel. Common types of mass flow meters include Coriolis meters, thermal meters, impeller meters and twin turbine meters. Volumetric flow rates must be determined using commercially available devices that measure the flow rate of a fluid flowing through a measurement channel. Common types of mass flow meters include rotameters, turbine meters, orifice meters, wedge meters, ultra-sonic flow meters and vortex flow meters.
Frequency of monitoring/recording	Monitored continuously (i.e., one measurement at least every 15 minutes)
QA/QC procedures to be applied	The metering equipment must be installed and calibrated in accordance with the specifications of either local/national standards or the manufacturer. Where local/national standards or the manufacturer specification is not available, international standards (e.g., IEC, ISO) may be followed.
Purpose of data	Calculation and differentiation of emissions associated with reductions and removals in mixed feedstocks
Calculation method	Direct measurement (preferred) or calculated from several measurements where it is demonstrated that the result is sufficiently accurate (i.e., 2 percent uncertainty at a 90 percent confidence interval)
Comments	Refer to US EPA (2010) for further guidance.

7 REFERENCES

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EU (2009). Directive 2009/31/EC of the European Parliament and of the Council of 23 April 2009 on the geological storage of carbon dioxide and amending Council Directive 85/337/EEC, European Parliament and Council Directives 2000/60/EC, 2001/80/EC, 2004/35/EC, 2006/12/EC, 2008/1/EC, and Regulation (EC) No 1013/2006. *Official Journal of the European Union*, 5.6.2009, L140–114-35.

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APPENDIX 1: CATEGORIZATION OF BIOMASS

The flowchart in Figure 4 provides a guide to assist in the categorization of biomass. By following the decision paths in the flowchart, project proponents can accurately classify their biomass feedstock into specific categories, such as forest biomass, agricultural biomass, and other forms. This categorization is fundamental for determining the applicable sustainability principles and documentation routes, thereby ensuring the sustainability of biomass used in projects.

Figure 4: Flowchart for Identifying Biomass Categories

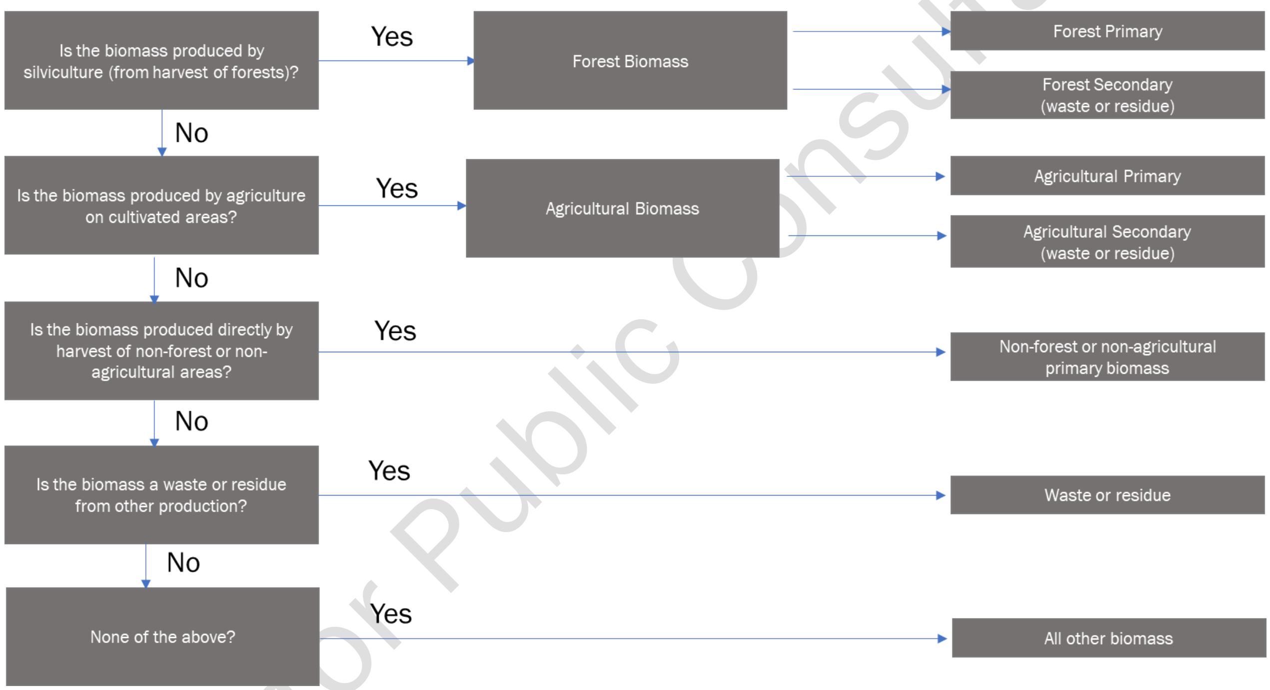

Figure 5 provides an overview of the main biomass types and the category to which they belong. Biomass in the category "All other biomass" is not eligible under this module.

The biomass types in the eligible categories are illustrative, not exhaustive. Project proponents may use another biomass type in the mentioned categories and provide justification of the category to which it belongs using the flowchart in Figure 4.

Figure 5: Overview of Biomass Categories and Biomass Types

Forest Primary

Everything originating directly from harvests in forests:

- Roundwood
- Thinnings
- Harvest residues
- Tops/branches
- Stumps
- Wood chips/pellets made from these resources

Forest Secondary (waste or residue)

Waste and residues from the wood product industry:

- Sawmill residues
- Sawdust
- Shavings
- Off cuts
- Bark
- Wood chips/pellets made from these resources

Non-forest or non-agricultural primary biomass

Biomass originating from areas that are neither agricultural nor forest:

- Waste from gardens and parks
- Trees outside forest
- Biomass from management of nature areas

Agriculture Primary

Main product of production in cultivated areas:

- Cereals (such as corn, wheat, barley)
- Grass (such as Miscanthus, sugar cane)
- Other energy crops (such as sugarbeet, potatoes)
- Pulses
- Whole crop silage
- Short rotation coppice (such as willow, poplar)
- Wood from agricultural plantations

Agriculture Secondary (waste or residue)

Wastes and residues from agricultural production:

- Straw
- Husks
- Corn cobs
- Wood from fruit tree plantations
- Unharvested parts of crops

Other waste or residue

Biogenic waste and residues from production that is neither agriculture-based nor forest-based

- Waste from food/feed industries
- Sludge
- Livestock manure
- Bagasse
- Municipal solid waste
- Tertiary wood waste
- Lignin

All other biomass

Everything biogenic that does not fit into any other category

APPENDIX 2: DEMONSTRATION OF SUSTAINABLE BIOMASS

Biomass feedstocks are often sourced directly from forestry or agricultural activities and thus must adhere to sustainability principles related to land use, biodiversity and carbon balance. On the other hand, waste feedstock for waste-to-energy (WtE) plants comprises materials that have already been used and discarded. These waste materials present a different set of sustainability considerations. The primary function of WtE is treating waste that cannot or should not be recycled.

Project proponents are required to determine the applicability of each principle and the suitability of each demonstration method for their specific biomass type following the procedures described here.

Note: The following section will be harmonized with the principles and requirements for biomass released as part of the update to the 5th version of the Verra Standard.

A2.1 Sustainability Principles for Biomass Feedstock (Excluding Waste to Energy Plants)

The biomass feedstock must conform to the following eight sustainability principles.

1. **Land use and biodiversity:** Biomass feedstock sourcing must respect land use patterns, specifically avoiding regions with high biodiversity, high carbon stocks and peatlands that have been converted or disturbed. This includes primary or highly biodiverse forests (identified by national authorities), designated nature protection areas (by national laws, international agreements or the International Union for the Conservation of Nature), highly biodiverse grasslands, wetlands and continuously forested areas.
2. **Sustainable forest management**: Biomass feedstock must balance growth and harvesting to ensure long-term forest resource sustainability, implement adaptive measures to maintain forest health and vitality, conserve biodiversity by protecting ecosystems, habitats and species, protect and restore threatened species and habitats, support genetic diversity through the use of native species and local provenances and maintain and enhance protective functions, including soil conservation and water quality. Forest regeneration must always occur, and feedstock must not be sourced from primary or old-growth forests.
3. **Soil health:** Biomass feedstock production must maintain or improve soil health. Soil health must at least include soil carbon.
4. **Water:** Feedstock production practices must be employed to preserve or improve water quality, as well as to use water efficiently and prevent the over-extraction of surface or groundwater resources beyond their renewal capacities.
5. **Food security:** Feedstock production must not compromise food security. Feedstock production activities, including agricultural, silvicultural, commercialization and exploitation activities, must not be conducted in areas with restrictions or embargoes placed due to deforestation.

6. **Social sustainability:** Biomass feedstock sourcing must ensure respect for free, prior and informed consent (FPIC) and must ensure no negative impact on local communities and economic opportunities. This includes impacts on tenure, indigenous peoples and workers' rights.
7. **Land use, land-use change and forestry (LULUCF):** The country from which biomass is sourced must be a party to the Paris Agreement and must have submitted a Nationally Determined Contribution (NDC) that covers emissions and removals from agriculture, forestry and land use and that accounts for changes in carbon stock towards the country's commitment. Additionally, the country must have laws that address the conservation of carbon stocks and provide evidence that emissions from the LULUCF sector do not exceed removals. Alternatively, a management system that ensures the long-term preservation of carbon stocks and sinks is acceptable. In cases where the country/region is not party to the Paris Agreement, compliance with appropriate management systems (e.g., GGLS5, Sustainable Biomass Program (SBP) or similar) must be demonstrated.
8. **Land-based leakage:** Biomass feedstock sourcing must avoid land-based leakage of GHG emissions, and project proponents must provide documented evidence of this avoidance by following the procedures described in Appendix I, which is specific to biomass type.

It should be noted that not all principles apply to all biomass types. As such, project proponents must use Table 1 to determine which sustainability principles apply to their biomass type (identified using Figure 4) and must evidence sustainability by certification or regulatory compliance, as outlined below. Where evidence of one type is insufficient, types may be combined.

Table 1: Sustainability Principles to Demonstrate for Each Biomass Category

Biomass Categories		Means of Demonstration[1]	Sustainability Principles[2]							
			1	2	3	4	5	6	7	8
Forest	Primary	AB	M	M	M	M	M	M	M	M
	Secondary	AB	M	M	M	M	M	M		
Agricultural	Primary	AB	M		M	M	M	M		M
	Secondary	AB	M		O	O	O	M		
Other	Non-forest, non-agricultural biomass primary	AB	M		O	O	O	O		
	Waste/residues	AB				O	O	M		

1 - A: regulatory compliance; B: sustainability certification

2 - M: mandatory; O: optional

A - Regulatory compliance

Biomass subject to a regulatory scheme may be considered to meet the sustainability principles of this module where a qualified third-party confirms that the sustainability requirements under of regulatory scheme meet or exceed the principles in this module. Relevant regulatory schemes include:

i) UK Renewables Obligation 2015 (as amended)

ii) Directive (EU) 2018/2001 of the European Parliament and of the Council of 11 December 2018 on promoting energy from renewable sources and its transposition in individual EU member states and/or the transposition in individual EU member states.

Biomass must always comply with the most recent applicable regulations. Regulatory compliance is relevant where the source facility is in a jurisdiction in which the regulation applies.

B - Sustainability certification

Biomass certified under an approved scheme from a legislative bodies or international bodies such as the European Union,[4] CORSIA,[5] or national/state governments is considered to meet the abovementioned sustainability principles. Proponents must provide evidence of such certification. These include:

i) Forest biomass: Forest Stewardship Council (FSC 100% and FSC Mix Credit), Program for Endorsement of Forest Certification (100% PEFC), Sustainable Biomass Program (SBP-Compliant Biomass) and similar

ii) Agricultural biomass: International Sustainability and Carbon Certification (ISCC), Roundtable for Sustainable Biomaterials (RSB), RenovaBio or similar

Traceability

Documenting the chain of custody is a general requirement for sustainable biomass, and for demonstrating the eight sustainability principles. Sustainable biomass must be traceable from sources through third-party audited records, ensuring a transparent chain of custody, The project proponent must provide relevant annual data about biomass feedstock consumption including biomass type and category, volumes, origin, certification, and other relevant information. Where such information is unavailable for a given quantity of biomass feedstock, that quantity is considered non-traceable biomass.

A2.2 Sustainability Principles for Waste-to-Energy Plant Biomass Feedstock

Project proponents must demonstrate adherence to the following sustainability principles for biomass feedstocks used in WtE plants. Where these requirements have been met, the biogenic content of waste streams processed by WtE plants is considered sustainable and certification is not required.

[4] The Renewable Energy Directive (RED) regulated by European Commission Directorate General for Energy (DG Energy) approves certain certification schemes for sustainable biofuel as part of its target of sustainable fuels in transportation in Europe.

[5] ICAO under its CORSIA scheme approves certification schemes for eligible biofuels to be used in international aviation as part of the international aviation industry's emissions reduction targets.

1) **Adherence to the waste treatment hierarchy:** Feedstock used in a WtE plant must follow the waste treatment hierarchy. This hierarchy prioritizes waste prevention, preparation for reuse and recycling, followed by other recovery methods, such as energy recovery, with disposal as a last option. This adherence may be demonstrated through comprehensive waste management plans that are reported to the national authorities. Regular reporting should be delivered to national authorities.
2) **Pre-sorting of recyclable waste:** Prior to the introduction of feedstock into WtE facilities, recyclable constituents must be separated from residual waste to the greatest extent practicable. This segregation may be efficiently executed either at the initial point of curbside collection or via a subsequent pre-sorting mechanism within the broader waste management infrastructure. Such practices are essential for optimizing the efficiency and environmental sustainability of WtE processes.
3) **Traceability of waste:** Waste materials processed in WtE plants must be traceable from their point of origin. This traceability ensures that the waste has been managed in a manner that is both legal and safe, thereby safeguarding public health and environmental integrity. Evidence of such traceability may be substantiated through a comprehensive suite of documentation, encompassing waste transfer notes, receipts and detailed reports. These documents must demonstrate responsible and transparent handling of waste materials throughout its lifecycle, culminating in processing at WtE facilities.