Gold Standard for the Global Goals

METHODOLOGY

GS4GG PAA M400-16

SDG 13

PRODUCTION AND APPLICATION FOR THE REMOVAL OF CARBON VIA BIOCHAR (PARC)

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SUMMARY

This methodology applies to activities that convert sustainably sourced biomass into biochar by pyrolysis or gasification and place it in a sink that ensures durable carbon storage: agricultural or forestry soil, engineered materials, or dedicated anoxic vaults. It credits durable carbon dioxide removals only; avoided emissions from the counterfactual fate of the biomass are not credited.

Activities are assigned to one of three compliance tracks by the rated input capacity of their production units, and the monitoring requirements are set to match:

- **Track 1 (Distributed Production):** manual and semi-manual units (e.g., flame-curtain kilns) below 1 tonne of dry biomass input per day per unit, operated in networks under an aggregator; conservative standardised default factors and composite sampling are permitted. Track 1 activities are micro- or small-scale (at most 60,000 tCO2e per year per activity or VPA), assessed together with related activities or VPAs where Section 3.2 | so provides.
- **Track 2 (Mechanised Transition):** mechanised retorts and containerised continuous units of 1 to 15 tonnes per day per unit; direct weighing is required and a thermal proxy for methane destruction is permitted.
- **Track 3 (Industrial Precision):** industrial facilities above 15 tonnes per day per unit; continuous emissions monitoring and batch-specific laboratory analysis are required.

Feedstock is admitted under six modules (Annex 1) and biochar is placed under three end-use modules (Annex 3); each module states the tracks under which it is available.

- **Module F1 (Field Residues):** Agriculture and forestry residues left after harvest or logging operations (e.g., straw, stover, logging slash, branches, tops.).

- **Module F2 (Processing Residues):** Residues generated at centralised agro-industrial processing facilities (e.g., rice husks, bagasse).
- **Module F3 (Restorative Biomass):** Biomass sourced from the removal of Invasive Alien Species (IAS) or bush encroachment.
- **Module F4 (Disaster & Sanitary):** Biomass removed for verified wildfire prevention or sanitary disease control (Track 2 and Track 3; Track 1 for wildfire fuel-load reduction only).
- **Module F5 (Purpose-Grown):** Biomass cultivated specifically for biochar on degraded or marginal land (restricted to Track 3); sourcing, land condition and eligibility governed by Annex 8.
- **Module F6 (Organic Waste):** Biogenic waste streams requiring pathogen control, and advanced emissions filtration, such as animal manure, digestate, biosolids, or segregated biogenic fraction MSW (restricted to Track 3 only).

End-Use Application Modules are restricted to verifiable, non-combustion sinks:

- **Module A1 (Soil Application):** Application to agricultural or forestry soil (including remediation).
- **Module A2 (Engineered Materials):** Encapsulation in non-combustible, inert concrete, asphalt, or composite building materials (Track 2 and Track 3 only).
- **Module A3 (Engineered Anoxic Storage)**: Storage in engineered, oxygen-limited subterranean environments (dedicated earth vaults). Active or capped Municipal Solid Waste (MSW) landfills are strictly prohibited. Restricted to Track 2 & 3.

Production and application may be carried out by different entities linked by digital chain of custody. Removals are quantified as the carbon expected to remain in the sink after 200 years, net of all activity emissions and leakage, and issued as Gold Standard Verified Emission Removals after the reversal-risk and downward-adjustment deductions of Section 11.

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Gold Standard for the Global Goals

GS4GG PAA M400-16 · SDG 13 · SECTORAL SCOPES 17, 15, 13, 4 · ENGINEERED REMOVALS

VERSION **1.0**
DURABILITY **200 yr · 1,000 yr**
MITIGATION **Removals**

PARC Production and Application for the Removal of Carbon via Biochar

Crediting durable carbon dioxide removal when sustainably sourced biomass is converted to biochar by pyrolysis or gasification and placed in soil, engineered materials or sealed earth vaults.

MITIGATION TYPE
Durable CO_2 removals only
Avoided emissions from the counterfactual fate of the biomass are not quantified or credited.

ACTIVITY SCALE
Micro · Small · Large
Track 1 capped at 60,000 tCO_2e per year per activity or VPA; related activities assessed together.

CREDITING PERIOD
5 years, renewable twice (15)
Restorative (F3) and purpose-grown (F5) biomass: renewable once, 10 years in total.

GEOGRAPHY · GWP
Global · IPCC AR5, 100-year
CH_4 28. Biomass sourced and biochar applied within the Host Country; no transboundary import.

COMPLIANCE TRACKS
Assigned by rated per-unit capacity in tonnes of dry biomass input per day; upgrade-only transition — S.3.2.1 · TABLE 3

T1 Distributed Production — < 1 t/day
TECH	Flame-curtain kilns and open or semi-open batch systems; biomass ignition only
MRV	Annex 5 conservative defaults; composite samples ≤ 50 t or 1 month; aggregator liable
MODULES	F1, F2, F3, F4 (wildfire only) · A1 soil only

T2 Mechanised Transition — 1–15 t/day
TECH	Retorts or modular continuous units with a secondary combustion chamber
MRV	Direct weighing of input; thermal proxy for methane; composite samples ≤ 100 t
MODULES	F1–F4 · A1, A2, A3

T3 Industrial Precision — > 15 t/day
TECH	Engineered pyrolysis or gasification plants; SCADA control; full syngas combustion
MRV	Automated weighbridges, CEMS and batch analysis per lot (≤ 24 h) at ISO 17025 labs
MODULES	F1–F6 · A1, A2, A3

FEEDSTOCK MODULES
Biogenic only; mixed feedstocks under any track meet every relevant module — ANNEX 1 · ANNEX 8

F1 T1 T2 T3 — **Field residues**
Straw, stover, logging slash, branches and tops

F2 T1 T2 T3 — **Processing residues**
Rice husks, bagasse from agro-industrial facilities

F3 T1 T2 T3 — **Restorative**
Invasive alien species or bush encroachment removal

F4 T1* T2 T3 — **Disaster & sanitary**
Wildfire prevention or disease control; *T1 wildfire only

F5 T3 only — **Purpose-grown**
Degraded or marginal land only, no use since 31 Dec 2020

F6 T3 only — **Organic waste**
Manure, digestate, biosolids, sorted biogenic MSW; ^{14}C tested

END-USE SINKS
Verifiable, non-combustion sinks with proof of application and digital chain of custody — S.3.2.11 · ANNEX 3

A1 Soil application · all tracks
Agricultural, forestry or remediation soils. Charging with manure or compost allowed; mass logged before blending.

A2 Engineered materials · T2, T3
Encapsulated in non-combustible concrete, asphalt or composites; Assignment of Rights from the manufacturer.

A3 Anoxic earth vaults · T2, T3
Impermeable liner, sealed cap and restrictive covenant. Active or capped MSW landfills prohibited.

BIOCHAR STABILITY · MOLAR H:C_{ORG} · S.3.2.9

≤ 0.4	≤ 0.5	0.5–0.7
Track 1 · 200-year route only	Track 2, 3 · 200-year, Method 1	Only via inertinite, R_o ≥ 2%, Method 2

Track 2 and 3 also require O:C_{org} ≤ 0.2. 1,000-year claims need ≥ 500 reflectance point-counts, credited at mean less one standard deviation. Track 1 defaults corroborated by third-party testing at least annually.

PRODUCTION & EFFICIENCY GATES

450°C	NCER ≥ 5	500
Minimum in the carbonisation zone	Carbon stored over activity emissions	Iodine mg/g: activated carbon ineligible

No fossil fuel to sustain the reaction; Track 1 ignition with biomass only. Upstream emissions of ineligible co-products accounted in full, with no allocation.

CORE APPLICABILITY · S.3.2

THERMAL	Thermal Compliance Protocol: location, residence time, sensor class. Track 1 may rely on a certified test-burn.
ADDITIVES	Mineral additives non-hazardous and excluded from creditable dry mass.
IMPREGNATION	No bio-oil, wood vinegar or tars re-applied to biochar; no condenser link to output in Track 2 and 3.
STORAGE	Biomass kept aerobic. Biochar heaps ≤ 10 days, bagged ≤ 30 days; re-characterised after 12 months.
BIOMASS	Annex 8 surplus test and sustainable extraction; retained carbon ≥ 10 years in baseline fate is ineligible.
UNIT LIFE	Credits only while a unit is operational; mobile units register each site and never pool lots across sites.

INELIGIBLE · S.3.2.3

- Waste tyres and plastics
- Coal and fossil carbon
- Hazardous e-waste
- Commingled unsorted MSW
- Activated carbon, met. coke
- Biochar used as fuel
- Export outside Host Country

DOUBLE-COUNTING CONTROLS · S.3.4

RIGHTS	Contracts with suppliers, producers and appliers; exclusive right to removals.
A2	Assignment of Rights keeps removals out of manufacturer EPDs.
BIOMASS	Feedstock credited under A/R or soil-carbon activities excluded.
YIELD	Aggregator mass balance; batches above Annex 5 maximum yield quarantined.
CUSTODY	No digital chain of custody, zero removals.

COMMON PRACTICE · MT400-06 · S.6.5 — Per feedstock collection area

$$F = P_{sim} / P_{all}$$

F ≥ 15% all countries → not additional

Biochar units for durable storage without carbon finance, over all units converting the same feedstock. Fuel charcoal, activated carbon and torrefied biomass excluded. Reassessed at renewal and on any material change in area, feedstock, baseline practice or VPAs.

ADDITIONALITY PATHWAYS · TABLE 7

A · Positive List
T1/T2 micro or small in LDC/SIDS, or exclusively F3 biomass without existing subsidy.

B · Barrier analysis
T1 and small T2: financial, institutional or information barriers.

C · Investment analysis
AMT-002; mandatory for Track 3 and large-scale Track 2.

Lock-in · MT400-09
T1 Track A; T2, T3 Track B with NCER as the Step 3 benchmark.

Mandatory for all: regulatory surplus, lock-in, common practice. Not renewed if biochar, energy and by-product revenue met the benchmark.

ISSUABLE GSVERS · EQ. 29

$$ER_{total,y} = NET_{CDR,y} - RISK_{penalty,y} - DAF_{deduction,y}$$

$NET_{CDR} < 0 \rightarrow$ zero issued, deficit carried forward

NET REMOVALS · EQ. 24-25

$$NET_{CDR,y} = AR_y - BR_{crediting,y} - Deductions_y - Deficit_{y-1}$$

$$Deductions_y = AE_y + LE_y$$

The full lifecycle footprint is deducted against removals before any buffer or ambition deduction.

AR Activity removals

SECTION 8

$$AR_y = \Sigma_i\ Q_{biochar,i} \times (1-MC_i) \times C_{org,i} \times F_{perm,i} \times (1-L_{app,i}) \times 44/12 \times (1-UNC_{AR}) \quad \text{Eq. 5}$$

Q	Wet mass per batch or 24 h lot; hanging scales, platform scales or weighbridge by track
MC	Measured; Track 1 default 15% air- or snuff-quenched; water-quenched always measured
C_{org}	Lab analysis; default (T1, T2 if selected) 0.55 woody, 0.45 herbaceous, 0.35 rice husk
F_{perm}	Lookup(H:C_{org}, MAST), Eq. 7; Track 1 0.754 at 25°C. Inertinite capped 0.95, Eq. 8. A2, A3 fixed 0.95
L_{app}	5% mechanised soil, 2% precision placement, 1% A2 and A3; zero if weighed at placement
UNC	5% Track 1 and 2; Track 3 deducts total error above 1% at 95% CI

AE Activity emissions

SECTION 9

$$AE_y = (AE_{supply} + AE_{prod} + AE_{trans} + AE_{app}) \times (1 + UNC_{AE}) \quad \text{Eq. 9}$$

SUPPLY	Pre-processing, Eq. 12; wet-pile CH_4, Eq. 10; F5 cultivation
ENERGY	Start-up fuel and metered electricity incl. SCADA and CEMS, Eq. 14
CH_4 T1	Kiln 0.0055 at ≤ 15% moisture, 0.020 at >15–24%; >24% not creditable, Eq. 15
CH_4 T2	Zero if SCC ≥ 850°C for ≥ 2 s; excursion 0.15 tCH_4/t char, Eq. 16
CH_4 T3	CEMS concentration × stack volume × 10^{-9}, Eq. 17
TRANS	Distance × payload × EF, Tool 02, incl. lab samples, Eq. 18
APP	Machinery fuel plus SOC loss from deep tillage, Eq. 19; manual zero

LE Leakage

SECTION 10

$$LE_y = (LE_{emb} + LE_{mkt} + LE_{eco} + LE_{shift}) \times (1 + UNC_{LE}) \quad \text{Eq. 20}$$

EMB	0.02 (T1) or 0.05 (T2) tCO_2e/t char, Eq. 21; or LCA ÷ 5 years, Eq. 22, mandatory for T3
MKT	Only on surplus-test failure: diverted mass × replacement factor, Eq. 23
ECO	F1 only: N, P, K replacement and foregone SOC, set by the residue's baseline fate, Eq. 23a
SHIFT	F5 only: zero on qualifying degraded land, otherwise ineligible

REPLACEMENT FACTORS · TABLE 12

Boiler fuel → coal: 1.75 woody · 1.30 herb.
Cooking fuel → LPG: 0.27 woody · 0.20 herb.
Fodder, bedding, mulch: site-specific

BASELINE · EQ. 1-4

$$BR_{unadj} = 0 \cdot BR_{BAU} = Mandated \times EF_{enf}$$

$$BR_{crediting} = MAX(BR_{unadj}, BR_{BAU})$$

Uncharred biomass returns to air within 10 years. EF_{enf} 1.0 enforced, 0.5 partial, 0 no mandate.

EFFICIENCY CHECK · EQ. 26

$$NCER_y = Q_{dry} \times C_{org} \times 44/12 \div (AE_{supply} + AE_{prod} + AE_{trans} + AE_{app})$$

Below 5: nothing issued; positive balance banked for up to three periods.

BUFFER & AMBITION · EQ. 27-28

$$RISK = NET_{CDR} \times Rate \cdot DAF = NET_{CDR} \times 1.25\%$$

Rate ≥ 2.5%. Cancelled: T1 soil 10%, A2 3%. Buffer: A3 2.5%; T2/T3 soil by Annex 7 (base 7.5%). DAF for 2026–2030.

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1| KEY INFORMATION

1.1.1 | The following table describes the key information for the application of methodology.

Table 1. Key information

Term	Description
Activity summary	The activity involves the thermochemical conversion of eligible biomass feedstocks into biochar — a stable, porous, carbon-rich solid — via pyrolysis or gasification, and its subsequent durable storage in eligible soil or engineered materials or dedicated anoxic earth vaults to remove carbon dioxide from the atmosphere.
Mitigation type	☒ Removals
Applicable activity scale	☒ Micro scale (≤10,000 tCO_2e per year; treated as small-scale for all purposes of this methodology) ☒ Small scale (≤60,000 tCO_2e per year) ☒ Large scale (>60,000 tCO_2e per year)
Sectoral Scope	Sector 17: Other activities involving removals Sector 15: Agriculture, Forestry, and Other Land Use (AFOLU) Sector 13: Waste Handling and Disposal Sector 4: Manufacturing Industries (Specific to engineered materials)
Activity Requirement	Engineered Removals Activity Requirements
Activity start date	**Track 1 & Track 2:** The date of commissioning of the first biochar production unit. **Track 3:** The earliest date on which the Activity Developer has committed to implementation of the activity (e.g., equipment purchase or facility construction).
Crediting Period start date	The start date of the crediting period is the date of the start of operations or a maximum of two years prior to the date of activity design certification, whichever occurs later. The activity start date is determined in accordance with the GS4GG Rule Update: Definition of Start Date, Engineered Removal Activities, and the activity may be submitted for preliminary review within three years of the activity start date in accordance with that Rule Update.

Crediting period length	Standard: 5 years, renewable twice (total 15 years). Restorative Biomass (Module F3) and Purpose-Grown (Module F5): 5 years, renewable once (Total 10 years).
Geographical applicability	Global Note: Module F3 (Restorative) and Module F5 (Purpose-Grown) have specific regional limitations based on national regulations (e.g., Invasive Species Lists) and land classification data.
Limitations	Activities utilising fossil-fuel based feedstocks (e.g., waste tires, plastics) or feedstocks containing non-biogenic carbon are strictly prohibited. Waste tires are entirely ineligible as their non-biogenic (fossil) carbon fraction cannot be reliably segregated or excluded. Municipal Solid Waste (MSW) is only permitted under Track 3 where rigorous physical sorting of the biogenic fraction is mandated. Mixed biomass sources are permitted provided they comply with the strict requirements of all applicable Feedstock Modules.

2| DEFINITIONS

2.1.1 | The definitions outlined in the Glossary of Gold Standard for the Global Goals and the Activity Requirements shall apply, in addition to those outlined below:

Table 2. Terms and definitions

TERM	DEFINITION
Aggregator	The entity responsible for organising and managing multiple distributed production facilities (Track 1) or community clusters (Track 2). The Aggregator can be the same entity as the Activity Developer, or an appointed third party, assuming operational responsibility for data aggregation, monitoring, quality assurance, and verification on behalf of the individual producers. Where the Aggregator is not the Activity Developer, it assumes operational responsibility for these tasks, but ultimate liability for the activity remains with the Activity Developer that signs the Gold Standard registry terms and conditions.
Anoxic Storage	The storage of biochar in an oxygen-limited environment (specifically sealed, dedicated earth vaults) designed to inhibit oxidative decay and ensure long-term stability of carbon in the biochar. Active methanogenic MSW landfills are strictly excluded.
Biochar	A solid material generated by heating biomass to a temperature of at least 450°C under conditions of controlled and limited oxidant supply (pyrolysis or gasification) to prevent total combustion. To be

	eligible under this methodology, the material shall meet the definition of "stable". For Track 1, to ensure maximum conservativeness in the absence of advanced continuous testing, the biochar shall exhibit a molar Hydrogen to Organic Carbon ratio ($H{:}C_{org}$) of ≤ 0.4. For Track 2 and Track 3, the biochar shall exhibit an $H{:}C_{org}$ ratio of ≤0.5 for the standard 200 year durability claim. Biochar with 0.5 < $H{:}C_{org}$ ≤ 0.7 is creditable only where durability is demonstrated petrographically (Mean Random Reflectance (R_o)≥ 2%); the same demonstration is required for 1000-year high durability claims. For the avoidance of doubt: biochar with a molar $H{:}C_{org}$ ratio of 0.5 or below (0.4 or below under Track 1 where measured) qualifies for the standard 200-year durability route (Method 1), and a lower ratio is not penalised; the 0.5–0.7 band is creditable only via the inertinite petrography route (Method 2), which is optional and available to Track 2 and Track 3 only; Track 1 uses the 200-year route exclusively.
Biogenic Carbon	Carbon derived from organic matter of recent biological origin (plants, animals, microorganisms), distinct from fossil carbon which is derived from geological deposits.
Composite Sampling	A monitoring approach permitted for Track 1 and Track 2 activities where physical sub-samples from multiple distinct production batches are systematically mixed to form a single "Master Sample" for laboratory analysis. Sub-samples may be composited into a Master Sample only where they originate from the same feedstock category and were processed under identical thermal parameters; sub-samples from distinct production lots or feedstock categories shall not be blended into a common Master Sample. This method ensures cost-effectiveness while maintaining statistical representativeness of the aggregated volume. A Master Sample shall represent a maximum of 50 metric tonnes (Track 1) or 100 metric tonnes (Track 2), or a maximum time boundary of 1 calendar month.
Continuous Emissions Monitoring System (CEMS)	The total equipment necessary for the determination of a gas or particulate matter concentration or emission rate using pollutant analyser measurements and a conversion equation, graph, or computer program. Mandatory for Track 3.
Earth Vault	A dedicated, engineered storage unit for biochar – subterranean or, where a shallow water table precludes burial, above ground or raised (Annex 3) - characterised by a low-permeability liner and a sealed cap, distinct from active or capped MSW disposal sites.
Feedstock Modules	The specific categories of biomass eligibility defined in this methodology: (refer to Annex 1 for details) F1 (Field Residues); F2 (Processing Residues); F3 (Restorative); F4 (Disaster/Sanitary); F5

	(Purpose-Grown, Track 3 only); F6 (Organic Waste, Track 3 only). The Feedstock Modules are distinct from the additionality "Positive List" referenced in Section 6, which is an additionality-demonstration instrument.
Flexible Activity Boundary	An operational model recognising dynamic value chains. Physical boundaries (e.g., application fields) can be dynamically added to the registered activity over time via digital registries, provided activity developer maintains strict contractual Chain of Custody and retains exclusive carbon rights.
Inertinite	The highly stable, non-reactive fraction of organic carbon in biochar, characterised by a Random Reflectance (R_o) ≥ 2%. This fraction is petrographically similar to geological coal, is insensitive to soil temperature decay and is considered to have a mean residence time exceeding 1,000 years. It serves as the primary high-durability metric for Track 2 and Track 3 and as the sole basis for crediting biochar with 0.5 < H:C_org ≤ 0.7.
Mean Annual Soil Temperature (MAST)	The annual mean temperature of the soil at the application site, used in the determination of the 200-year permanence factor (Annex 6). MAST shall be sourced from an open, traceable soil-temperature dataset (e.g. NASA POWER, SoilGrids or ERA5-Land). Non-integer values are rounded up to the next whole degree and the value is not taken below the 7^0C floor of Annex 6. Track 1 may apply the conservative default of 25^0C; Track 2 and Track 3 shall use the gridded dataset.
Mid-Period Track Transition	A one-directional (upgrade-only) change of an activity from a lower-rigour to a higher-rigour Compliance Track (Track 1 → Track 2, or Track 2 → Track 3) during a crediting period, subject to Validation and Verification Body confirmation and prospective application of the receiving Track's MRV requirements (Section 3.2.1.10 |). Transition to a lower-rigour Track is not permitted.
Negative Leakage	An increase in emissions or a decrease in removals occurring outside the activity boundary that is attributable to the activity. Negative leakage shall be quantified and deducted; positive (beneficial) leakage shall not be credited.
Net Carbon Efficiency Ratio (NCER)	A mandatory efficiency metric calculated as the ratio of the carbon stored in the biochar placed in the sink (dry mass × organic carbon content × 44/12), before the permanence, loss and uncertainty adjustments of Section 8, to the activity emissions of supply, production, transport and application, before the uncertainty adjustment of Section 9.7 and excluding leakage. Eligible activities shall maintain an NCER ≥ 5 for each monitoring period.

Purpose-Grown Biomass	Biomass cultivated specifically to serve as feedstock for biochar production (Module F5). Under this methodology, this is restricted to biomass grown on confirmed degraded, marginal, or contaminated lands and is eligible only for Track 3 activities.
Restrictive Covenant	A legal obligation imposed in a deed or lease by the landowner that restricts the use of the land (e.g., prohibiting excavation) to ensure the permanence of the carbon sink.
Restorative Biomass	Biomass sourced from the removal of Invasive Alien Species (IAS) or bush encroachment vegetation (Module F3), where the removal contributes to ecosystem restoration and biodiversity recovery.
Small Processing Hub	A centralised chipping, grinding or drying facility serving distributed (Track 1) or small mechanised (Track 2) production, with a rated throughput at or below 15 tonnes of feedstock per day, the capacity boundary between Track 2 and Track 3. Track 1 and Track 2 activities sourcing from such a hub may apply the default pre-processing emission factor of Annex 5 in place of metered data. A hub whose cumulative rated throughput across all units it serves exceeds 15 tonnes per day shall not apply the default and shall meter its energy use under Track 3 energy accounting (Annex 5); the compliance track of the activity is unaffected.
Social Permanence	The concept utilised in Track 1 where the durability of a carbon sink (biochar in soil) is reinforced by the tangible agronomic and economic benefits it provides to the user (e.g., increased crop yield), thereby creating a rational disincentive for reversal (excavation or misuse).
Sustainable Biomass	Biomass (waste or purpose-grown) that is sourced without causing a long-term decrease in carbon stocks and without causing negative impacts on biodiversity, water, or food security. It shall comply with the biomass surplus and sustainability requirements in Annex 8, read with the feedstock eligibility of Annex 1.
Sustainable Biomass - Surplus Test	Surplus Test — the assessment in Annex 8 (A8.4) by which biomass is demonstrated to be genuinely surplus (existing-use screen, supply-shed headroom, no manufactured supply), re-tested at renewal.
Thermal Compliance Protocol	The set of parameters by which a production unit demonstrates compliance with the minimum-temperature requirement (Section 3.2.4 |): the temperature measurement location (the carbonisation zone), a minimum indicative residence time at or above 450°C, and the minimum sensor accuracy class. For Track 1, a one-time pre-commissioning certified test-burn may serve as a recurring compliance proxy. Detailed specifications are given in Annex 4.

Thermal Proxy Monitoring	A simplified monitoring approach permitted for Track 2 where the destruction of methane and other pyrolysis gases is verified by continuously monitoring the temperature and residence time of a secondary combustion chamber (e.g., T > 850^0C for > 2s), serving as a proxy for direct emissions measurement.
Track 1: Distributed Production	A compliance track characterised by networked, micro-scale operations (individual unit capacity below 1 tonne of dry-biomass input per day) where biochar production is integrated into agricultural or livelihood systems. Limited to activities certifying at most 60,000 tCO_2e per year per standalone activity or VPA, related activities or VPAs being assessed together (Section 3.2). Verification relies on aggregated assurance and conservative standardisation.
Track 2: Mechanised Transition	A compliance track characterised by mechanised batch retorts or containerised continuous systems (individual unit capacity from 1 to 15 tonnes of dry biomass input per day). Verification relies on direct weighing of inputs and Thermal Proxy Monitoring for emissions, serving as a bridge between artisanal and industrial quantification.
Track 3: Industrial Precision	A compliance track characterised by centralised, continuous-flow facilities with integrated process controls (individual unit capacity above 15 tonnes of dry biomass input per day). Verification mandates direct instrumental measurement (e.g., CEMS, automated weighbridges) and batch-specific laboratory analysis.
Waste Biomass	Biomass residues from agriculture, forestry, or industrial processes (Modules F1, F2, F4, F6) that are diverted from their baseline fate exclusively for the purpose of durable carbon removal.

3| SCOPE, APPLICABILITY, AND ENTRY INTO FORCE

3.1 | Scope

3.1.1 | This methodology is applicable to activities that sequester CO_2 through the thermochemical conversion of sustainably sourced biomass into biochar and its subsequent application in the durable–storage sinks defined by Modules A1 – A3.

3.1.2 | The activity boundary covers the cradle-to-grave lifecycle, encompassing biomass sourcing, pre-processing, biochar production, transport, and final application. An activity shall be considered eligible only when it demonstrates compliance with all criteria defined in this section.

3.1.3 | This methodology credits durable carbon dioxide removals only. Avoided emissions from the counterfactual fate of the biomass and sustainable-development co-benefits may be described in activity documentation but shall not be quantified or credited. No avoided-emission quantity shall enter the net removal calculation.

3.2 | Applicability

The methodology is applicable to activities that demonstrate compliance with the following conditions.

3.2.1 | **Compliance Track Selection:**

3.2.1.1 | To accommodate diverse production scales while ensuring rigorous quantification, the activity shall be implemented under one of three Compliance Tracks. The Activity Developer shall select the applicable Track at the time of Design Certification and adhere to the specific MRV requirements defined in Table 3.

3.2.1.2 | Track assignment is determined by the per-unit processing capacity (tonnes of dry biomass input per day, as defined in Table 3) together with the annual Track 1 removal threshold of 60,000 tCO2e (section 3.2.1.3 |), irrespective of whether a production unit is fixed, mobile, modular or containerised. A mobile, modular or containerised unit is classified by its rated per-unit capacity; an activity operating multiple units is classified by reference to the applicable per-unit capacity and to the annual Track -1 removal threshold. A mobile or modular unit that operates at more than one geographic site shall register each distinct operational site; biochar produced at different sites by the same unit shall not be aggregated into a single production lot, and the emissions of relocating the unit between sites shall be quantified and deducted.

3.2.1.3 | **Track 1 (Distributed Production)** is available to micro- and small-scale activities only: certified removals of at most 60,000 tCO_2e per year per standalone activity or per Voluntary Project Activity (VPA), assessed together with related activities or VPAs where the de-bundling provisions below apply. The threshold does not apply per production unit. Where certified removals would exceed 60,000 tCO_2e in a year, issuance shall be capped at 60,000 tCO_2e and the removals beyond the cap in that year are not creditable. An activity expecting to exceed the cap shall transition to Track 2 or Track 3 under the Mid-Period Track Transition provision below before those removals are generated.

3.2.1.4 | **Scale determination and de-bundling**: Scale is determined for each standalone activity or VPA. A PoA may include any number of VPAs; no limit applies at programme level.

3.2.1.5 | Two or more activities or VPAs applying this methodology are assessed together as one activity for the purpose of the Track 1 threshold where they are under common beneficial ownership or common operational control, whether or not registered under different participants or legal entities, and at least one of the following applies:

a | they share an aggregation hub or production site;

b | their boundaries lie within 1 km of each other;

c | they started, or were included in a PoA, within two years of each other.

3.2.1.6 | Where activities or VPAs are assessed together, their scale is the sum of their certified removals. An activity or VPA whose combined scale exceeds the Track 1 threshold shall not use Track 1 and shall meet the requirements of the track that applies to the combined scale.

3.2.1.7 | Activities or VPAs held by distinct beneficial owners, each controlling its own production units and biochar, are not grouped solely because they use a common aggregator, training provider, monitoring system, PoA or this methodology.

3.2.1.8 | At validation, at each VPA inclusion and at each verification, the activity developer shall disclose the coordinates of each production site and application area, beneficial ownership and operational control, and any other activity applying this methodology within 1 km or under common beneficial ownership. The VVB shall confirm which activities or VPAs are assessed together. Where this information was withheld or misstated, the activity is assessed together with the related activities or VPAs from its validation or inclusion and the matter is addressed as a non-conformity under the GS4GG rules.

3.2.1.9 | Where Gold Standard publishes a standard-level de-bundling requirement applicable to this activity type, that requirement supersedes these provisions from its effective date.

Table 3. Compliance Track Selection Matrix

Attribute	Track 1: Distributed production	Track 2: Mechanised Transition	Track 3: Industrial Precision
Primary Scale	Artisanal Input: **< 1 tonne/day** (per unit)	Mechanised Input: **1 to 15 tonnes/day** (per unit)	Industrial Scale Input: **> 15 tonnes/day** (per unit)
	Track assignment follows rated per-unit capacity irrespective of unit mobility, together with the annual Track 1 removal threshold of 60,000 tCO_2e (section 3.2.1.3 |).		
Scale cap	≤ 60,000 tCO_2e/yr per activity or VPA (related activities assessed together, Section 3.2 |)	None	None
Typical Technology	Open-flame or semi-open batch systems	Semi-controlled retorts or modular continuous systems	Fully engineered continuous or batch pyrolysis plants or gasification plants

			with integrated syngas combustion[1].
Process Control	Manual Operation; temperature estimation via portable sensors.	Semi-Automated; integrated control of residence time and air flow. Partial temperature feedback.	Fully Automated; real-time SCADA control of temperature, feed rate, and residence time.
Flue gas compliance	Methane minimisation; relies on "Flame Curtain" to combust pyrolysis gases.	Thermal destruction; secondary combustion chamber or thermal oxidiser to destroy gases.	Advanced abatement; full syngas combustion/CHP; compliant with industrial air quality standards.
MRV Approach	Conservative standardisation; use default factors (Annex 5).	Hybrid measurement; direct weighing of input required; thermal proxy permitted for emissions.	Direct measurement; automated weighing and continuous emissions monitoring (CEMS) required.
Biomass Eligibility	Restricted to modules F1, F2, F3 and F4 (Wildfire Only)	Restricted to modules F1, F2, F3, F4.	All Modules (F1–F6).
End-Use Eligibility	Restricted to Module A1 (Soil) only	All Modules (A1–A3).	All Modules (A1–A3).
Applicability	Global	Global	Global

3.2.1.10 | **Mid-Period Track Transition (Upgrade Only):** An activity developer may transition an activity to a higher-rigour Compliance Track (Track 1 → Track 2, or Track 2 → Track 3) during a crediting period, subject to all of the following conditions. Transition to a lower-rigour Track is not permitted.

a | completion of the Gold Standard design change process, a track transition constituting a design change;

b | VVB review - as part of verification - confirming that the activity meets the receiving Track's eligibility and MRV requirements; and

[1] It is recognized that even for lower capacity units such machines would be available commercially. For such cases, the activity shall select the appropriate track (track 2 or track 3, Track 1 will not be eligible)

c | application of the receiving Track's MRV requirements to all removals quantified from the effective date of transition. Removals quantified before the transition date shall remain governed by the originating Track's requirements, and no retrospective re-quantification is permitted.

3.2.2 | **Financial and Economic Screening:** The activity shall meet the following criteria:

3.2.2.1 | **High-Value Product Exclusion:** Activities producing commercial high-value carbon products such as Activated Carbon (Iodine Number > 500 mg/g, ASTM D4607) or Metallurgical Coke are fundamentally incompatible with the durable storage requirements of this methodology. They are ineligible for crediting. Where a facility produces a mix of eligible biochar and ineligible high-value carbon products, all upstream and processing GHG emissions associated with the production of the ineligible product volume shall be fully accounted for as activity emissions. Mass-based or economic allocation of upstream emissions across co-products is not permitted.

3.2.2.2 | **Net Carbon Efficiency Ratio (NCER):** The activity shall demonstrate a NCER of at least 5 for each monitoring period, calculated in accordance with Section 11.4 | as the ratio of the carbon stored in the biochar placed in the sink to the activity emissions of the period.

3.2.3 | **Biomass Sourcing Eligibility:** The activity shall utilise biomass complying with one of the approved Feedstock Modules (F1–F6) and the criteria below.

3.2.3.1 | **General Eligibility:** The feedstock shall be biogenic. Feedstocks containing fossil carbon (e.g., coal, waste tires, plastics) or hazardous electronic waste are strictly prohibited.

a | **Exception for Track 3 (Module F6):** Municipal Solid Waste (MSW) and other organic waste streams containing fossil fractions are eligible only when processed in a Track 3 facility with advanced sorting. Source separation shall occur at the point of generation or through a verified materials-recovery process before pyrolysis; commingled waste that has not undergone verified source separation is ineligible. Recognising that 100% mechanical purity is not physically achievable, the biogenic carbon fraction of the resulting biochar shall be substantiated by Radiocarbon (^{14}C) testing in accordance with the Radiocarbon Monitoring provision below. Only the verified biogenic fraction is eligible for crediting; the corresponding fossil CO_2 emissions shall be fully accounted for, and the fossil fraction of the resulting biochar is ineligible.

b | **Radiocarbon (^{14}C) Monitoring (**Module F6 only; Module F5 purpose-grown biomass, being wholly biogenic, is exempt**):** The biogenic carbon fraction shall be determined by Radiocarbon analysis in accordance with ASTM D6866 or EN 16640. An initial baseline phase shall establish the mean biogenic fraction by testing one composite sample per 1,000 tonnes processed or per month, whichever is the more frequent, for the first six months of operation. Where inter-sample variance over the baseline phase is demonstrably

low, the testing frequency may be reduced to one composite sample per quarter. For any reduced-frequency period, the creditable biogenic fraction shall be the conservative lower bound (the lower 95% confidence limit) of the established distribution. The analytical standards (ASTM D6866 or EN 16640) are specified in Annex 1, Module F6.

3.2.3.2 | **Mixed Feedstocks:** Activities under any Track may use biomass that falls into more than one Feedstock Module. The activity shall demonstrate compliance with the sustainability requirements of every relevant module. Activities applying the Annex 5 default carbon content (Track 1; Track 2 where elected) take the default of the lowest-carbon component unless the blend composition is documented to within ±10% by dry mass (Annex 5).

3.2.3.3 | **Biomass Sustainability Requirements:** Feedstock eligibility, surplus testing, and sustainable extraction rates shall be strictly governed by the Annex 8 (Biomass Surplus & Sustainability Requirements), along with the feedstock modules of Annex 1.

3.2.3.4 | **Biomass Storage Requirements:** To prevent anaerobic decay and methane generation prior to pyrolysis, the biomass shall be stored in appropriate conditions based on the quality of the biomass (e.g., type, moisture content, degradability). The activity developer shall follow national, regional, or local guidelines on the storage of biomass. Where unavailable, international best practices shall apply, including but not limited to the following:

a | **Temperature and Shade:** Maintaining appropriate temperature and preventing direct sunlight exposure (to prevent combustion or accelerated decay). Where biomass is stored in open sites, the developer shall justify the practice (e.g., via daily mixing or upturning of biomass to prevent anaerobic pockets).

b | **Moisture control:** Ensuring adequate moisture control (via aeration or partial drying before storage) such that it physically prevents accelerated anaerobic degradation but is not low enough to inculcate spontaneous combustion.

3.2.3.5 | **Host Country Boundary:** For the purposes of this methodology, the Host Country is the jurisdiction in which the biochar is produced, durably applied or stored and in which the resulting removal is credited. Biomass shall be sourced from within the Host Country, and biochar shall be durably applied within the Host Country. Biochar applied outside the Host Country boundary cannot be verified for durable storage and is ineligible for crediting. Transboundary import of biomass for the purpose of biochar production under this methodology is prohibited.

3.2.4 | **Biochar Production Criteria**

3.2.4.1 | **Minimum Temperature and Thermal Compliance Protocol:** The reactor shall maintain a minimum temperature of 450°C during the conversion phase to ensure proper carbonisation and prevent the creation

of degradable torrefied biomass. Compliance shall be demonstrated against a Thermal Compliance Protocol specifying:

a | the temperature measurement location (the carbonisation zone);

b | a minimum indicative residence time at or above 450°C; and

c | the minimum sensor accuracy class.

For Track 1, a one-time pre-commissioning certified test-burn — demonstrating that the approved technology (e.g. a Flame Curtain kiln) achieves the required temperature and residence time — may serve as a recurring compliance proxy in place of continuous measurement, provided the feedstock category and reactor design remain materially unchanged. The binding eligibility test in all cases remains the biochar stability threshold (Section 3.2.9.1 |). Sensor and procedural specifications are given in Annex 4 (Thermal compliance measurement).

3.2.4.2 | **Fossil Fuel Restriction:** Fossil fuels shall not be used to sustain the thermochemical reaction in any Track, and mixed MSW plastics shall not be used as fuel in any Track. For Track 1 (open-kiln / flame-curtain operation), fossil fuels shall not be used at any stage, including start-up; ignition shall be achieved using biomass. Any fossil ignition aid is prohibited for Track 1; permissible ignition is limited to biomass tinder or a renewable ignition source. For Track 2 and Track 3, a limited, metered fossil-fuel allowance is permitted for start-up or initiation only where technically unavoidable, and the associated emissions shall be fully accounted for as activity emissions.

3.2.5 | **Additives:** Mineral additives (e.g., clay or ash) added to the biomass or biochar are permitted only where they do not introduce hazardous substances and are separately quantified. Mineral additive mass shall be excluded from the quantity of biochar eligible for crediting. The Activity Developer shall determine the net creditable biochar mass on a dry basis by subtracting the verified mineral additive mass from the measured biochar output. Where direct additive measurement is not practicable, a representative post-production analysis or another conservative, verifiable mass-balance method included in the monitoring plan may be used. No hazardous substances shall be added.

3.2.6 | **Production unit operational life and credit eligibility:** Credits may be issued for biochar produced by a production unit only while the unit is operational and compliant with this methodology. The Activity Developer shall document the unit's commissioning date, operational status, capacity and production records.

3.2.7 | Seasonal or intermittent operation does not by itself end the operational life, provided the unit remains available for operation and the Activity Developer provides evidence of its operational status and production during the monitoring period. No credits shall be issued for production after a unit has been permanently decommissioned unless a verified replacement unit is operational and has been added to the activity boundary or registry in accordance with applicable GS4GG requirements.

3.2.8 | Where a unit is replaced, credits may continue only after the replacement unit has been verified as equivalent to or more conservative than the replaced unit for the applicable Compliance Track and its operation is documented in the monitoring plan.

3.2.9 | **Biochar Quality**

3.2.9.1 | **Stability:** The produced biochar shall meet stability thresholds. For Track 1, the biochar shall exhibit a molar Hydrogen to Organic Carbon ratio ($H{:}Corg$) of ≤ 0.4. For Track 2 and Track 3, the biochar shall exhibit an $H{:}Corg$ ratio of ≤ 0.5 for standard durability claims. In addition, for Track 2 and Track 3 the molar oxygen to organic carbon ratio ($O{:}Corg$) shall not exceed 0.2, determined from total oxygen (ISO 16948, DIN 51733 or by difference) and Corg on the same sample and reported alongside H:Corg; a batch exceeding 0.2 is ineligible notwithstanding compliance with the H:Corg threshold. Track 1 activities applying the Annex 5 defaults are exempt from per-batch testing of both ratios; where a Track 1 activity tests, both ratios shall be reported. Biochar with 0.5 < H:C_org ≤ 0.7 is creditable only where the inertinite petrography method (Annex 4; Mean Random Reflectance Ro ≥ 2%) is used to demonstrate durability. Any batch or composite sample exceeding these thresholds is deemed ineligible for crediting.

3.2.9.2 | **Durability Stratification:** Activities claiming high durability (1,000+ years) shall use Method 2 (Section 8.5 |, Equation 8; Annex 4): available for Module A1 under Track 2 and Track 3. The permanence factor is the product of the inertinite fraction and the non-reactive carbon fraction, each taken at its mean less one standard deviation across at least three replicate samples of at least 500 reflectance point-counts, and is capped at 0.95; the inertinite fraction counts particles with random reflectance (R_o) of ≥ 2.0%.

3.2.9.3 | **Track 1 Default-Factor Corroboration:** Track 1 activities relying on the conservative default factors (Annex 5) in lieu of per-batch $H{:}Corg$ testing shall, in addition, be subject to a light periodic third-party characterisation of representative biochar to corroborate the conservative defaults applied, undertaken at least annually and additionally upon any material change in feedstock category or production technology.

3.2.9.4 | **Prohibition of Impregnation:** The re-injection, spraying, or soaking of liquid pyrolysis by-products (e.g., bio-oil, wood vinegar, tars) onto the solid biochar output is strictly prohibited.

3.2.9.5 | **Exception (Charging under Module A1):** Charging biochar with non-pyrolytic agricultural additives (e.g., manure, compost, microbial tea) is permitted under Module A1. The net creditable biochar mass ($Q_{biochar}$) shall be weighed and recorded before any additive is blended, and the addition of additives shall be logged separately. No additive mass shall be included in the creditable biochar quantity.

3.2.9.6 | **Track 2 (Mechanised) and Track 3 (Industrial):** The facility shall not have piping or other connections that connect the condensation unit back to the biochar output stream.

3.2.10 | **Biochar Storage and Transport:**

3.2.10.1 | **Stored Biochar** - the inert product, distinct from pre-pyrolysis biomass, which is governed by the Biomass Storage Requirements in Section 3.2.3 |— is subject to the following limits, which guard against re-wetting and weathering loss:

a | **Heap Storage:** Biochar shall not remain on site for more than 10 days and heaps shall be managed to prevent spontaneous combustion.

b | **Bagged Storage:** Biochar shall not remain on site for more than 30 days unless protected from moisture and direct sunlight.

c | **Documented exceedance:** where a storage limit is exceeded, the exceedance shall be documented and the moisture and mass of the affected biochar re-confirmed before that quantity is credited. Where biochar has been stockpiled for more than 12 months, its stability parameters shall additionally be re-characterised before crediting, to account for any weathering or oxidation during prolonged storage. An exceedance shall not, of itself, render the biochar ineligible where no material degradation or loss is evidenced.

d | **Transport:** Non-packaged biochar transported via truck or rail shall be covered (e.g., tarpaulin) to prevent wind-blown loss and cross-contamination. Biochar shall not be transported alongside flammable fossil fuels.

3.2.11 | **End-Use Application:**

3.2.11.1 | The activity shall apply biochar to a sink that ensures durable storage. Eligible application modules are:

a | **Module A1 (Soil):** Application to agricultural, forestry, or remediation soils.

b | **Module A2 (Engineered Materials):** Encapsulation in non-combustible, inert matrices: asphalt (binder and base courses) or composite building materials (Annex 3). Biochar may be supplied unblended to the manufacturer provided strict B2B non-combustion encapsulation contracts are executed.

c | **Module A3 (Engineered Anoxic Storage):** Storage in engineered environments. Under this methodology, Module A3 is a Dedicated Earth Vault – subterranean, or above ground/raised where shallow water tables preclude burial - achieving anoxic containment via an impermeable liner and a sealed, low-permeability cap, subject to a legal restrictive covenant; detailed engineering requirements are specified in Annex 3. Active or capped Municipal Solid Waste (MSW) landfills are strictly prohibited. Module A3 is restricted to Track 2 and Track 3.

3.2.11.2 | The Activity Developer shall provide proof of application (e.g. geo-tagged photographs, weighing receipts or end-user agreements) to satisfy verification requirements.

3.3 | Entry into force

3.3.1 | The date of entry into force is the publication date of this methodology.

3.4 | Mandatory Compliance and Safeguards

3.4.1 | **Contractual Obligation & Aggregation**

3.4.1.1 | **Ownership:** The activity developer shall demonstrate clear legal ownership of the carbon credits rights. This includes establishing contractual agreements with biomass suppliers and biochar producers and downstream application entities to ensure no double counting occurs. The activity developer shall confirm that they retain an exclusive right to the net GHG removals achieved.

3.4.1.2 | **Aggregator liability:** For Track 1 (distributed) and Track 2 (community clusters), the aggregator acts as the primary operational manager and assumes operational responsibility for data accuracy, safety compliance and credit distribution; ultimate liability remains with the Activity Developer (Section 2|) on behalf of the distributed producers.

3.4.1.3 | **Mass Balance Check (yield safeguard):** The aggregator shall verify that the aggregated biochar output volume is physically consistent with the recorded biomass input volume.

3.4.2 | **Double Counting Mitigation**

3.4.2.1 | **End-User Claims:** The activity developer shall conform with the *GHG Emissions Reduction & Sequestration Product Requirements*. Where biochar is used in non-soil applications (Module A2), the developer shall obtain a contractual "Assignment of Rights" from the downstream manufacturer to prevent the manufacturer from claiming the removal in their own GHG inventory (e.g., Environmental Product Declaration).

3.4.2.2 | **Scope 3 "Insetting":** To prevent double claiming between the voluntary carbon market and corporate GHG Inventories: activities funded by a supply chain partner (e.g., an off-taker paying a premium for low-carbon crops to claim the removals in their supply chain or carbon negative cement) are ineligible for GSVER issuance unless a Carbon Rights Waiver is provided.

3.4.2.3 | **Stacking with other activities:** Where the biochar is incorporated into soil (Module A1), the activity developer shall confirm that the target fields are not part of an existing Soil Organic Carbon (SOC) activity aiming to claim net removals. If the fields are part of another carbon activity, the specific volume of biochar applied to those overlapping fields shall not be eligible to claim the removal benefit due to biochar under this methodology to prevent double crediting on the same land polygon.

3.4.3 | **Health and Safety**

3.4.3.1 | **Risk assessment:** A risk assessment shall be conducted for all hazardous and potentially hazardous materials used (e.g., solvents). Storage areas shall be physically separated from fossil fuels or ignition sources.

3.4.3.2 | **Air Quality (PM2.5/CO):**

a | **Track 1:** Production units shall be operated in open-air environments or well-ventilated structures. Operation within enclosed residential spaces is prohibited.

b | **Track 2&3:** Facilities shall comply with all applicable national regulations regarding flue gas emissions and workplace safety.

3.4.4 | **Environmental Safeguards**

3.4.4.1 | **Methane Abatement:** Traditional earth-mound kilns (charcoal clamps) are prohibited.

3.4.4.2 | **Soil Toxicity:** Biochar applied to soil (Module A1) shall meet recognised quality standards (e.g., EBC, IBI) for heavy metals and Polycyclic Aromatic Hydrocarbons (PAHs). For biochar produced below 500^0C or from high-chlorine or waste-derived feedstocks, testing shall additionally cover polychlorinated biphenyls (PCBs) and polychlorinated dibenzo-dioxins and -furans (PCDD/Fs), consistent with EBC practice. Where local or national regulations provide more conservative (stricter) thresholds for eligible heavy metals, the local regulations shall take absolute precedence.

a | Track 1 & 2 activities may utilise Composite Sampling to demonstrate compliance.

b | Track 3 activities shall utilise Batch-specific analysis.

3.4.5 | **Social Safeguards (Social Permanence)**

3.4.5.1 | **Agronomic Security:** The biochar application rates shall strictly align with documented regional agronomic best practices, local agricultural extension recommendations, or peer-reviewed literature and shall not exceed 50 tonnes of dry biochar per hectare per application on any field, calculated as a field-level broadcast average; precision placement is assessed on the placed area. Certified brownfield or mine-tailing remediation sites are exempt where a qualified environmental engineer or agronomist specifies a higher rate (Annex 3).

3.4.5.2 | **No-Burn Guarantee:** Any biochar sold or diverted without explicit, geo-tagged proof of application in an eligible, non-combustible sink is strictly ineligible for crediting.

3.4.6 | **Safeguards for Anoxic Storage (Module A3)**

3.4.6.1 | **Groundwater Protection:** The base of a subterranean Dedicated Earth Vault shall be separated from the seasonal high water table by a minimum of 1.5 metres. Where this clearance cannot be achieved, subterranean storage is not permitted; an above-ground or raised vault may be used as provided in Annex 3.

3.4.6.2 | **Future-Proofing:** The storage site shall be subject to a legal instrument (e.g., Environmental Covenant or Deed Restriction or Easement) prohibiting excavation for not less than the credited durability period (200 years), and running with the land so as to bind all successors in title.

3.4.7 | **Technology Graduation (Sunset Clause – Track 1)**

3.4.7.1 | Track 1 activities are encouraged to evaluate a structural upgrade - to Track 2 (mechanisation) or to digital "Smart Kiln" verification - at the time of Crediting Period Renewal. Mandatory graduation requirements may be introduced at a future revision and will not apply retrospectively (Section 18.4).

4| NORMATIVE REFERENCES

4.1.1 | The following standards, methodologies, tools, and guidelines are normative references for the application of this methodology. Activity developers shall apply the latest valid version of these documents.

4.1.2 | References to CDM tools are valid until equivalent tools are published under Gold Standard (GS4GG) or the Article 6.4 Mechanism (A6.4)/Paris Agreement Crediting Mechanism (PACM).

4.1.2.1 | GS4GG Standards and Requirements

a | Principles and Requirements

b | Requirements for Paris Agreement Alignment (PAA-PR100-01)

c | Safeguarding Principles and Requirements

d | GHG Emissions Reduction & Sequestration Product Requirements

e | Engineered Carbon Removal Activity Requirements

f | Programme of Activities (PoA) Requirements

g | Gender Equality Guidelines and Requirements

h | Rule Update: Definition of Start Date, Engineered Removal Activities (2026)

4.1.2.2 | GS4GG Methodologies, Standards, and Tools

a | Requirements for Additionality Demonstration

b | Requirements for Baseline Determination in Methodologies

c | Requirements for Addressing Leakage in Methodologies

d | TOOL 1: Emissions from fossil fuel consumption

e | TOOL 2: Emissions from freight transportation

f | TOOL 5: Downward Adjustment Factor (DAF) Determination

g | TOOL 6: Common Practice Analysis

h | TOOL 8: Technical addendum to the A6.4 technical lifetime of equipment, applied with A6.4-AMT-006

i | TOOL 9: Analysis of Lock-in Risk

j | TOOL 10: Technical addendum to the A6.4 grid emission factor tool

k | Supplementary Information to this methodology: basis, evidence and derivation of its provisions and default values (informative)

4.1.2.3 | UNFCCC/A6.4 Tools and Standards:

a | Emissions from electricity generation and consumption (A6.4-AMT-007)

b | Investment analysis (A6.4-AMT-002)

c | Sampling and surveys (A6.4-AMT-010)

d | Requirements for activities involving removals under the Article 6.4 mechanism (A6.4-STAN-METH-002)

e | Addressing non-permanence and reversals of removals in mechanism methodologies (A6.4-STAN-METH-007)

f | CDM TOOL16: Project and leakage emissions from biomass (until superseded by an Article 6.4 mechanism tool)

g | CDM TOOL12: Project and leakage emissions from transportation of freight (until superseded by an Article 6.4 mechanism tool)

4.1.2.4 | Other Sources:

a | ISO 16948: determination of total oxygen in solid biofuels and solid fuels; DIN 51733: ultimate analysis and calculation of oxygen content in solid fuels (O:Corg, Section 3.2).

b | ISO/IEC 17025: General requirements for the competence of testing and calibration laboratories. (Mandatory for laboratory elemental analysis).

c | ASTM D1762 / ISO 18134: Standard test methods for moisture, volatile matter, and ash in biomass/charcoal.

d | ISO 7404-5:2025 / ASTM D2798: Methods of determining microscopically the reflectance of vitrinite/inertinite.

e | EPA Method 1613B / EPA 8290 / EN 16190: Determination of dioxins and furans (PCDD/F) by isotope-dilution high-resolution GC-MS (mandatory for Module A1 where the trigger of Section 3.4 applies: production below 500 °C, or high-chlorine or waste-derived feedstock)

f | European Biochar Certificate (EBC) / International Biochar Initiative (IBI): Normative thresholds for heavy metals, PAHs, and Dioxins/Furans to ensure safe agricultural soil application (Module A1).

g | IPCC (2019): 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 4, Chapter 10 (methane conversion factors for manure-management systems; Section 9.3).

5| ACTIVITY BOUNDARY AND GHGS SOURCES/SINKS

5.1 | Activity boundary

5.1.1 | The activity boundary encompasses all anthropogenic sources of GHGs and carbon sinks that are under the control of the activity developer, are related to the activity, or are significantly affected by the activity.

5.1.2 | The activity boundary shall be defined based on the cradle-to-grave lifecycle of the biochar, comprising the physical sites and transport links associated

with biomass sourcing, facility construction, biochar production, and durable application.

5.1.3 | **Spatial Boundary:** The activity developer shall clearly identify the spatial extent of the activity sites as follows:

5.1.3.1 | **Feedstock Collection Area:** The geographical area from which a specific feedstock type is collected or procured for the activity. Where more than one feedstock type or materially different collection area is used, each feedstock type and collection area shall be defined and assessed separately. This term is used for the common practice assessment in Section 6.5 | and is distinct from the Supply Shed defined in Section 17.2 | and Annex 8 (A8.4).

a | **Modules F1, F2, F3, F4 (Residues/Waste** and Restorative **Biomass):** The specific collection zones (e.g., farms, mills, invaded rangelands, fire-risk forests).

b | **Module F5 (Purpose-Grown):** The specific land parcels where cultivation occurs (restricted to Track 3).

c | **Module F6 (Organic Waste):** The municipal or agricultural waste facilities where the specific biogenic fraction is generated and segregated.

5.1.3.2 | **Biochar Production Site:** The physical sites where biomass processing (e.g., drying, chipping) and thermochemical conversion (pyrolysis/gasification) occur.

a | **Track 1:** Includes the network of artisanal kilns and the central Aggregator Hub.

b | **Track 2:** Includes the mechanised facility (e.g., containerised retorts) and any satellite pre-processing depots.

c | **Track 3:** The industrial plant footprint.

5.1.3.3 | **Biochar Application Site:** The geographical areas where biochar is applied to ensure durable storage.

a | **Module A1 (Soil):** Agricultural, forestry, or remediation lands.

b | **Module A2 (Engineered Materials):** The manufacturing facilities (e.g., concrete plants) where encapsulation occurs.

c | **Module A3 (Engineered Anoxic Storage):** The physical footprint of the dedicated earth vault, vertically defined from the base liner to the surface cap.

5.1.3.4 | **Transportation:** The mobile sources and routes used to transport biomass from source to production, and biochar from production to application.

5.1.4 | **Flexible Activity Boundary:**

5.1.4.1 | To reflect dynamic modern value chains, physical application boundaries (e.g., specific downstream agricultural fields or construction sites) are not required to be permanently fixed at the time of Design Certification. New application sites or distributed production units may be dynamically added to the registered activity during the crediting period via the Digital Monitoring System (DMS), provided the activity developer maintains a strict

contractual Chain of Custody and retains exclusive carbon rights across all entities.

5.1.5 | **Boundary Aggregation (Track 1 & 2):**

5.1.5.1 | For activities utilising an Aggregated or Cluster Structure:

a | **Hub/Cluster:** The central facility controlled by the Aggregator serves as the primary "Control Point" for weighing, sampling, and data management.

b | **Spokes:** The boundary extends to include all registered distributed production units.

c | **Liability:** The Aggregator assumes boundary liability for all emissions occurring at the distributed "Spoke" facilities.

5.1.6 | **Temporal Boundary:** The boundary covers the time from the start of facility construction and biomass collection up to the end of the crediting period.

5.2 | GHG Sources and sinks

5.2.1 | Emissions from fuels and biogenic processes can occur during biomass production, conversion, transport and application. The following sections identify the relevant GHG sources for the baseline scenario, the activity scenario, and leakage.

5.2.2 | **Carbon Sinks (Removals)**

5.2.2.1 | **Biochar carbon:** The durable storage of pyrogenic biogenic carbon in biochar is the primary and exclusive removal sink (CO_2).

5.2.3 | **Emission Sources (Activity emissions)**

a | **Biogenic CO_2:** Emissions of CO_2 from the combustion or decay of sustainable biogenic biomass are considered climate-neutral and are excluded from quantification ($CO_2 = 0$).

b | **Methane (CH_4):** CH_4 slip from pyrolysis is a Critical Source and shall be included.

c | **Nitrous Oxide (N_2O):** Included for Module F5 (Purpose Grown) fertiliser emissions.

5.3 | Baseline Emissions

5.3.1 | The following table details the GHGs included in, or excluded from, the baseline scenario(s).

Table 4. Sources of Baseline Emissions

SOURCE	DESCRIPTION	GAS	INCLUDED?	JUSTIFICATION
Biomass decay & open burning	Baseline aerobic/anaerobic decay or counterfactual open combustion	CO_2, CH_4, N_2O	No	Pure CDR Exclusivity: Avoided baseline emissions from decay or burning are explicitly excluded; no avoided-

	of waste/residue biomass (Modules F1, F2, F4, F6).			emission quantity enters the net removal calculation.
Biomass Cultivation	Modules F3, F5 Baseline vegetation dynamics.	CO_2, N_2O	No	Zero Baseline Rule: For Restorative (F3) and Purpose-Grown (F5), it is assumed no durable carbon storage occurs in the baseline. $BR_{unadj} = 0$
Energy Generation	Displacement of grid electricity or heat.	CO_2	No	Excluded. This methodology utilises a "CDR only" approach. Displacement of grid electricity or heat is not credited.

5.4 | Activity emissions

5.4.1 | The following table details the GHGs emissions included in, or excluded from, the activity scenario(s).

Table 5. Sources of Activity Emissions

SOURCE	DESCRIPTION	GAS	INCLUDED?	JUSTIFICATION
Biomass Supply *(Cultivation)*	Fertiliser and machinery use for crop production (Module F5); CH_4 from wet feedstock of any module stored for more than one month before processing (Section 9.3 |, Equation 10).	CO_2, N_2O CH_4	Conditional	Cultivation emissions are included for Module F5 only and excluded for all waste and residue modules. Storage methane is included for any module where wet feedstock is stored for more than one month (Section 9.3 |).
Biomass Processing (Pre-treatment)	Chipping, drying, shredding, or pelletising.	CO_2	Yes	Emissions from fossil fuels (diesel chippers) or grid electricity used for pre-processing. A default factor applies for sourcing from a small processing hub (Annex 5).

Biochar Production *(Pyrolysis – Methane Slip)*	Uncombusted pyrolysis gases released from the reactor.	CH_4	Yes	**Critical Source.** • **Track 1:** moisture-conditioned default factor (Annex 5; by feedstock moisture class, wet basis). • **Track 2: Thermal Proxy.** (T < 850°C triggers deduction). • **Track 3:** Measured via CEMS.
Biochar Production *(Pyrolysis – fossil fraction)*	Fossil carbon volatilised and combusted from MSW plastics.	CO_2	Conditional	Mandatory inclusion for Track 3 facilities utilising Module F6 (MSW) to account for incomplete biogenic sorting.
Auxiliary Energy	Energy for startup (ignition) or sustaining reactor controls.	CO_2	Yes	Emissions from electricity (blowers, feeders, controls) and, for Track 2 and Track 3 only, from a limited, metered fossil-fuel start-up allowance where technically unavoidable. Track 1 (open-kiln) ignition is achieved using biomass; no fossil start-up emissions arise (see Section 3.2.4 |, Fossil Fuel Restriction).
Transportation (Biomass & Biochar)	Logistics for feedstock and biochar.	CO_2	Yes	Emissions from trucks, rail, or shipping.
Biochar Application	Machinery for application/burial.	CO_2	Yes	Emissions from tractors/spreaders (Module A1) or mixing equipment (Module A2). Emissions from excavators, compactors, and

				capping machinery (Module A3).
Soil Disturbance (SOC Loss)	Loss of baseline Soil Organic Carbon (SOC) due to deep mechanical tilling.	CO_2	Conditional	Included only if Module A1 application forces severe mechanical disturbance on verifiable no-till agriculture or perennial grassland.

5.4.2 | **Specific Provisions for Track 2 (Mechanised)**

5.4.2.1 | **Thermal Proxy Monitoring:** Track 2 activities utilising mechanised retorts shall account for methane slip. Where the unit is equipped with a Secondary Combustion Chamber (SCC) or Thermal Oxidiser:

a | **Compliant State:** Emissions are deemed Zero for periods where the SCC temperature is continuously verified as ≥ 850^{0}C with a residence time ≥2 seconds.

b | **Excursion:** For periods where temperature drops below the threshold, the penalty factor (Annex 5) shall be applied to the volume produced during the failure window.

c | **Electricity:** Units requiring electricity — including automation, fans, SCADA and CEMS at the production facility and, at the application or encapsulation site, mixers and material-handling equipment — shall meter consumption for each mechanised unit and calculate emissions in accordance with the Emissions from electricity generation and consumption (A6.4-AMT-007) (consumption source: the activity production or application unit; relevant scenario A; the higher-value case 1 applied for conservativeness).

5.5 | Leakage emissions

5.5.1 | Leakage is the net change of GHG emissions occurring outside the activity boundary, attributable to the activity. The following table details the potential sources of leakage emissions that shall be assessed.

6Table 6. Sources of Leakage Emissions

SOURCE	DESCRIPTION	GAS	INCLUDED?	JUSTIFICATION
Embodied Emissions (Upstream)	Cradle-to-gate emissions associated with the manufacture, construction and transport of the activity devices.	CO_{2e}	Yes	Mandatory Inclusion. • Track 1 & 2: standardised default per tonne of biochar (Annex 5, Table 23); Track 3: inventory (Section 10.4 |).

				• Track 3: LCA-based deduction.
Market Effects (biomass diversion)	Non-participants switch to fossil fuels because biomass (e.g., F1, F2) was diverted to the activity.	CO_{2e}	Yes	**Conditional.** Mitigated by the surplus Test (Annex 8, A8.4)). If biomass is proven Surplus, Leakage = 0. If test fails, replacement (market – leakage) emissions are quantified. (Section 10.5; Table 12)
Ecological leakage (Nutrients & SOC)	Nutrient displacement and foregone SOC accumulation due to residue removal.	CO_2, N_2O	Yes	Mandatory for Module F1. Accounts for N-P-K fertiliser replacement and foregone natural carbon input. On same-field return, P/K replacement may be reduced where retained and returned; N is retained in full (volatilised in pyrolysis); foregone-SOC retained (Section 10|).
Activity shift *(Land Use)*	Displacement of food production to other lands due to biomass cultivation (Module F5).	CO_{2e}	Yes	Mandatory for Track 3 (Module F5). Excluded for all other waste/residue modules. Avoided where the Annex 8 (A8.8.2) land condition is met (degraded or marginal under the fixed-date test of Annex 1, with no conversion and no food/feed diversion).

6| DEMONSTRATION OF ADDITIONALITY

6.1 | Requirements

6.1.1 | The activity developer shall demonstrate that the activity would not have occurred in the absence of the incentives provided by the carbon revenues. The demonstration of additionality shall be conducted in accordance with the latest version of the *GS4GG:* Requirements for Additionality Demonstration.

6.1.2 | All activities, regardless of the Compliance Track selected, shall successfully complete the following mandatory analyses:

- a | Regulatory Surplus Analysis (Section 6.2)
- b | Lock-In Risk Analysis (Section 6.3)
- c | Additionality analysis as per the selected option (Section 6.4)
- d | Common Practice Analysis (Section 6.5)
- e | Ongoing Financial Need (at Renewal, per Section 18) (Section 6.6).

6.2 | Regulatory Surplus Analysis (Mandatory)

6.2.1 | The activity developer shall demonstrate that the activity is not mandated by any existing law, regulation, or mandates/binding obligations (legal requirements), within the host country's jurisdiction.

6.2.2 | The analysis shall verify that:

- a | **Mandate Biomass Conversion:** legal requirements do not require, in a manner that is enforced, the biomass feedstock to be converted into biochar or another stabilised carbon product (for example charcoal or torrefied biomass produced for durable, non-energy use; biomass fuel pellets, being destined for combustion, are excluded). A partial or unenforced mandate is addressed under Section 7.5 |.
- b | **Baseline - Fate laws:** laws prohibiting the baseline fate of the biomass (for example open-burning bans) do not affect regulatory surplus, because this methodology credits removals only and the baseline removal is zero (Section 7.3 |). Compliance with such laws shall nonetheless be assessed and documented.
  - i | **Enforcement and evidence:** For high-income countries (as classified by the World Bank), all relevant legal requirements shall be deemed to be enforced. For all other countries, a relevant legal requirement shall be deemed unenforced only on the basis of authoritative and up-to-date information of non-enforcement that is relevant and applicable to the activity (for example, official government reports or remote-sensing evidence).
- c | **Mandate Application:** legal requirements do not explicitly require the application of biochar to soil or materials.

6.2.3 | **Host Country Eligibility (Positive/Negative List):** The activity developer shall confirm that the mitigation activity type (biochar production and durable

storage) is legally eligible to operate and issue credits within the Host Country.

6.2.3.1 | **Demonstration of Compliance:** Compliance shall be demonstrated through one of the following, as applicable, at Validation and at Crediting Period Renewal:

a | **Official policy document:** A policy document or a legal framework of the Host country that permits, or does not prohibit, the generation of carbon credits from the proposed activity type.

b | **Official List Review:** A citation of the Host Country's most recent official Article 6 policy framework, decrees, or public eligibility lists (e.g., a "Negative List" or "Ineligible Activity List") published by the Designated National Authority (DNA) or Article 6 Focal Point, confirming the activity is not excluded.

c | **Explicit Authorisation:** Provision of a Letter of Authorisation (LoA) or No Objection from the Host Country's DNA that explicitly authorises the mitigation activity type or sector.

d | **Confirmation of No Exclusion (Default):** In the absence of a published negative list, positive list, or specific regulatory exclusion, the activity developer shall provide a formal declaration confirming that no official communication or regulation has been issued by the Host Country identifying the specific technology as ineligible for carbon crediting.

6.3 | Lock-In Risk Analysis (Mandatory)

6.3.1 | In accordance with the GS4GG Lock-In Assessment Tool, mitigation activities shall not lock the Host Country into high-emitting technologies or perverse baseline practices.

6.3.2 | Lock-in risk shall be assessed in accordance with TOOL 9: Analysis of Lock-in Risk (MT400-09). Track 1 activities are micro-scale and follow Track A of the tool: they complete Steps 1 and 2 and are deemed to have no lock-in risk where policy alignment is demonstrated. Track 2 and Track 3 activities follow Track B. For Step 1, the operational lifetime of the production unit is taken from the tool's default lifetimes or determined under TOOL 8. For Step 3, the net carbon efficiency ratio of Section 11.4 is the methodological benchmark: an activity meeting the NCER threshold of Section 3.2 satisfies Step 3 under Option 1 of the tool. For Step 4, the biomass surplus test of Annex 8 (A8.4) constitutes the resource-efficiency assessment for biomass; the tool's freshwater threshold applies where water quenching is used.

6.4 | Additionality Pathway Selection

6.4.1 | Following the mandatory analyses above, the activity developer shall demonstrate additionality through one of the options defined in Table 7, determined by the Compliance Track and Activity Scale.

7Table 7. Additionality Pathway Selection

Compliance Track	Eligible Scale	Permitted Approaches
Track 1 ***(Distributed)***	Micro/Small Scale ($\leq$60,000 tCO_2e/yr per activity or VPA, Section 3.2 |)	Option A: Deemed Additionality (LDC/SIDS, or exclusively Module F3 feedstock; Section 6.4 | Option A). Option B: Barrier Analysis. Option C: Investment analysis.
Track 2 ***(Mechanised)***	Micro/Small Scale ($\leq$60,000 tCO_2e/yr)	Option A: Deemed Additionality (LDC/SIDS, or exclusively Module F3 feedstock; Section 6.4 | Option A) Option B: Barrier Analysis. Option C: Investment analysis.
	Large Scale (> 60,000 tCO_2e/yr)	Option C: Investment analysis (Mandatory).
Track 3 ***(Industrial)***	All Scales	Option C: Investment analysis (Mandatory). *Barrier Analysis is Prohibited as a standalone demonstration.*

A. Option A: Positive List

6.4.2 | Activities meeting the criteria below are deemed additional under this methodology and are exempt from a separate Financial or Barrier Analysis.

6.4.2.1 | **Category 1: Small-scale activities in LDC/SIDS**

a | **Location:** The activity is located in a Least Developed Country (LDC) or Small Island Developing State (SIDS); and

b | **Technology:** utilises Track 1 or Track 2 technology and

c | **Scale:** meets the definition of Micro-Scale or Small-Scale ($\leq$60,000 tCO_2e/yr).

6.4.2.2 | **Category 2: Restorative Biomass (Module F3) Feedstock:** The activity is micro- or small-scale ($\leq$ 60,000 tCO_2e/yr) under Track 1 or Track 2 and exclusively utilises biomass from Module F3 (Restorative), specifically the removal of Invasive Alien Species (IAS) or bush encroachment. The developer shall demonstrate an absence of existing, systemic government subsidies that are already actively funding the specific invasive species removal.

B. Option B: Barrier Analysis:

6.4.3 | **Applicability:** Permitted exclusively for Track 1 (Distributed) and Micro/Small-Scale Track 2 activities.

6.4.4 | Barriers: The activity developer shall identify the barriers that prevent implementation of the activity and provide verifiable evidence that carbon credit revenue is the decisive element in overcoming each identified barrier. Barriers are limited to the following types:

a | **Financial barrier:** inability to access debt or equity financing on terms that permit implementation, for example for lack of collateral.

b | **Institutional barrier:** absence of the organisational, regulatory or supply-chain arrangements needed to implement the activity, including the absence of an established biomass collection chain in the collection area.

c | **Information barrier:** absence of local capacity or knowledge to operate production units safely and to the standard this methodology requires.

6.4.5 | Evidence: barriers shall be substantiated by independent, verifiable evidence (for example lender decisions, sector reports, surveys), applied conservatively so that it is very unlikely that the effect of a barrier is overestimated. The activity developer shall also show that at least one alternative to the activity, including the continuation of the current practice, does not face the identified barriers. Barrier analysis shall be combined with the common practice analysis of Section 6.5.

C. Option C: Investment/Financial Analysis

6.4.6 | **Applicability: Available to all Tracks; mandatory for Track 3 and large-scale Track 2.** The activity developer shall conduct a Benchmark or Investment Comparison in accordance with the Article 6.4 mechanism methodological tool: Investment analysis (A6.4-AMT-002), as applied under the GS4GG Requirements for Additionality Demonstration, including the sensitivity analysis the tool requires.

6.4.7 | **Approach:** The activity developer shall conduct a Benchmark Analysis or Investment Comparison Analysis.

a | **Input Parameters:** The analysis shall account for CAPEX (Equipment, Site), OPEX (Labour, Energy, Maintenance), Feedstock Logistics and all operational revenues, including but not limited to Sales of Biochar, Energy (if applicable), Co-products (e.g., Bio-oil), Municipal Waste Tipping/Gate Fees, and active Host Country government green-technology subsidies.

b | **Outcome:** Additionality is demonstrated where the investment analysis shows that

i | the activity would not meet the required financial benchmark without carbon-credit revenues;

ii | the economic performance of the activity increases decisively through carbon-credit revenues; and

iii | carbon-credit revenues can raise the economic performance to or above the required financial benchmark. The benchmark shall be consistent with the weighted average cost of capital (or the cost of equity, as applicable) for the country, sector and activity type. A sensitivity analysis on the critical assumptions, and an assessment period reflecting the expected operating life of the activity (or at least ten years), shall be conducted in accordance with the GS4GG Requirements for Additionality Demonstration.

6.5 | Common Practice Analysis:

6.5.1 | The common practice test shall be conducted at the feedstock collection area level for each feedstock type used by the activity, in accordance with the GS4GG Common Practice Analysis tool (MT400-06). The assessment boundary shall not be set at global, country or broad regional level unless the feedstock collection area is demonstrably coterminous with that level.

6.5.1.1 | For each feedstock type, the Activity Developer shall define and evidence the feedstock collection area, identify comparable activities within that area, and conduct the common practice assessment for the relevant baseline practice and technology. A separate assessment shall be completed when the collection area, feedstock type, baseline practice or included activity changes materially, including upon inclusion of a new VPA or PoA component. A change is material where the collection area changes by more than 10 per cent of its area, a feedstock type or baseline practice not previously assessed is introduced, or a VPA or component is added whose rated capacity exceeds 10 per cent of the registered capacity of the activity.

a | **Applicable Geographical Area (AGA**): The feedstock collection area, defined separately for each feedstock type .

b | **Target Market:** The relevant biomass-residue management and soil-amendment market within the feedstock collection area for the feedstock type assessed.

c | **Similar Activities (P_{sim}):** Production of biochar for durable storage without voluntary or compliance carbon finance. Charcoal for fuel, activated carbon and torrefied biomass are distinct products and are excluded. The share is measured on the installed base: comparable production units in operation in the collection area, divided by all units converting the same feedstock type, including the proposed activity.

d | **Threshold (F_{max}):** 15% in all Host Countries.

e | **Conclusion:** The Activity Developer shall document the share of comparable activities within the feedstock collection area that already use the proposed practice, using current local or sub-national evidence appropriate to the feedstock type.

f | **Result:** If the assessed share of comparable activities is below the applicable threshold, the activity is deemed not common practice and the additionality demonstration of Section 6.4 | stands. Where the threshold is met or exceeded, the activity is not additional under this methodology.

6.5.1.2 | The assessment shall be carried out at validation, repeated at each renewal of the crediting period, and updated whenever the feedstock collection area, feedstock type, baseline practice or included activity changes materially, including when a new VPA or PoA component is included. The

updated assessment shall use the attribute matrix below where a specific analysis is required.

Table 8. Attribute Matrix for Essential Distinction

Attribute	Activity	Distinct Activity (Excluded from P_{sim})
Activity output	Solid carbonaceous material (Char) ($H{:}Corg$ ratio of biochar is ≤ 0.5 and ≤ 0.4, where measured under Track 1; 0.5 to 0.7 creditable only under Method 2, Section 8.5)	Charcoal (fuel), activated Carbon (filtration)
Technology	Thermochemical conversion (Pyrolysis/Gasification) at > 450 °C	Incineration, torrefaction
End-Use Application	Durable storage / sequestration (e.g., Soil amendment, concrete, asphalt)	Combustion / Energy
Scale	Track 1, 2 or Track 3	Mismatched scale: an activity whose rated capacity places it more than one compliance track away from the proposed activity
Exclusion of carbon finance	Technologies distributed, subsidised, or mandated without voluntary or compliance carbon finance.	Yes

6.6 | Ongoing Financial Need

6.6.1 | At the renewal of the crediting period, the additionality of the activity shall be reassessed. The activity developer shall demonstrate Ongoing Financial Need in accordance with Section 7 of the GS4GG Requirements for Additionality Demonstration.

6.6.1.1 | **Requirement:** The activity developer shall demonstrate ongoing financial need in accordance with Section 7 of the GS4GG Requirements for Additionality Demonstration: an activity that applied Option C shall provide an updated investment analysis on actual costs and revenues; an activity that applied Option B shall provide updated evidence that the barriers relied upon persist; an activity that applied Option A shall confirm that the conditions of the positive list continue to be met. Binding, long-term carbon credit off-take agreements established prior to or during the first crediting period do not retroactively void additionality.

6.6.1.2 | The regulatory-surplus assessment shall be conducted prior to design review and at each Crediting Period Renewal.

6.6.1.3 | Any activity whose revenue from biochar sales and energy or by-products, excluding carbon credits, has met the applicable financial benchmark over the preceding crediting period is no longer additional and shall not be

renewed. Track 1 and Track 2 aggregated activities demonstrate ongoing need through the cost of aggregation, monitoring, hardware replacement and benefit sharing relative to biochar sales revenue.

7| BASELINE SCENARIO

7.1 | Baseline Determination (Stepwise Approach)

7.1.1 | The crediting baseline removals (BR_y), shall be determined following the stepwise approach mandated by the *GS4GG Standard: Requirements for Baseline Determination in methodologies*:

a | Step 1: Selection and Justification of the Baseline Approach (Section 7.2 |).

b | Step 2: Application of the selected approach prior to downward adjustment (Section 7.3 |).

c | Step 3: Application of the downward adjustment (Uncertainty and ambition) (Section 7.4 |).

d | Step 4: Identification of a conservative Business-as-Usual (BAU) baseline (Section 7.5 |).

e | Step 5: Comparison and selection of the final Crediting Baseline ($BR_{crediting,y}$) (Section 7.6 |).

7.2 | Step 1: Selection of and Justification of the Baseline Approach

7.2.1 | **Selection of Baseline Approach**

7.2.1.1 | This methodology *applies the baseline approach of paragraph 36(iii) of the Article 6.4 Rules, Modalities and Procedures, as implemented by GS4GG Requirements for Baseline Determination in Methodologies (MS400-04)— existing actual or historical removals, adjusted downwards.* The selection of this approach is justified as follows, in accordance with Requirement 7.2.2 of MS400-04: (a) no best-available-technology or ambitious benchmark exists for the baseline, because no practice in the baseline durably stores the carbon of residue biomass; (b) the actual fate of residue biomass — decay or combustion within ten years — is observable and site-specific, and the historical-actual approach represents it directly; and (c) the approach allows the downward adjustment for host-country ambition to be applied transparently at issuance (Section 11.6 |). The baseline removal is zero (Section 7.3 |).

7.3 | Step 2: Determination of the Unadjusted Baseline

7.3.1 | **Unadjusted Baseline Removals** (BR_{unadj}): For all Feedstock Modules (F1-F6), the Baseline Removal is set to Zero (0).

7.3.1.1 | In the baseline scenario (aerobic decay, anaerobic decay, or open combustion), uncharred biomass carbon returns to the atmosphere within a short, active biogenic carbon cycle (<10 years). Feedstock whose realistic

alternative fate would retain its carbon for ten years or more is ineligible under Annex 8.

$$BR_{unadj} = 0 \qquad \text{Eq. 1}$$

Where;

Where		
Parameter	**Description**	**Value**
$\boldsymbol{BR_{unadj}}$	Unadjusted Baseline Removals in monitoring period y (tCO_2e)	0

7.4 | Step 3: Application of the Downward Adjustment and Uncertainty

7.4.1 | **Adjustment for uncertainty ($\boldsymbol{UNC}$):** Because the Unadjusted Baseline Removals ($\boldsymbol{BR_{unadj}}$) are zero, baseline uncertainty is zero. All MRV uncertainty is applied exclusively to the ex-post Activity Removals (AR_y) and Activity Emissions (AE_y) and to Leakage in accordance with Section 13.

7.4.2 | **Application to removals (Ambition DAF):** The Paris Agreement – alignment adjustment shall be applied through the Downward Adjustment Factor ($DAF_{NetZero}$) derived from the *GS4GG Tool: Downward Adjustment Factor Determination*. Since $\mathrm{BR}_{\mathrm{unadj}} = 0$, the DAF is applied as annual deduction from the NET Removals ($NET_{CDR,y}$) at Section 11 (Equation 28); it is not applied at the baseline stage. The resulting deduction represents the Host Country's mitigation contribution and is reported transparently

$$BR_{adj,y} = NET_{CDR,y} \times DAF_{NetZero,y} \qquad \text{Eq. 2}$$

Where;

Parameter	**Description**	**Value**
$\boldsymbol{BR_{adj,y}}$	Downward adjustment deduction in period y.(tCO_2e)	Calculated
$\boldsymbol{NET_{CDR,y}}$	Net Verified Removals (CDR) in monitoring period y (tCO_2e)	Section 11
$\boldsymbol{DAF_{NetZero,y}}$	For application Period (e.g., 2026-2030), use the Global Ambition Floor (0.0125 i.e., 1.25%). (decimal)	GS Tool MT400-05
Note: This effectively establishes a "Crediting Baseline".		

7.5 | Step 4: Conservative BAU Scenario

7.5.1 | The activity developer shall determine whether the production and durable application of biochar is legally mandated in the Host Country or the relevant sub-national jurisdiction.

7.5.1.1 | **Regulated & Enforced:**

a | Where biochar production and durable application is fully legally mandated and that mandate is enforced, the activity is not additional and is ineligible under the regulatory-surplus screen (Section 6.2 |).

b | Where a partial or unenforced mandate applies, the conservative BAU removal is the legally mandated volume adjusted by the enforcement factor (Equation 3), and this volume is deducted as the crediting baseline

c | Where no such mandate exists, BAU removals for that source shall be set to Zero ($BR_{BAU,y} = 0$).

7.5.1.2 | **Geographic Specificity:** Where sub national laws are more stringent than national laws, the assessment shall be conducted at level of jurisdiction from which the biomass is procured.

7.5.1.3 | **Systematically Unenforced:** If a law exists but is systematically unenforced (non-compliance above 50%, evidenced as below), the mandate is treated as unenforced, $EF_{enf} = 0$ applies and the developer may proceed; this provision is not available where the Host Country is classified as high-income (Section 6.2 |). The activity developer shall provide independent evidence (e.g., peer-reviewed studies, government audit reports) not older than 3 years from the date of validation to prove systematic non-compliance.

$$BR_{BAU,y} = Mandated_Volume_y \times EF_{enf} \qquad \text{Eq. 3}$$

Where

Parameter	Description	Value
$BR_{BAU,y}$	Conservative BAU removals mandated by law in year y. (tCO_2e)	Calculated
$Mandated_{volume,}$	The physical volume of biochar removals legally required by the host jurisdiction.	Legal text
EF_{enf}	Enforcement factor	Enforced mandate = 1.0; partially-enforced = 0.5 (independent evidence ≤ 3 years); no mandate = 0.0

7.6 | Step 5: Selection of the Crediting Baseline

7.6.1 | **Crediting Baseline for Removals** ($BR_{crediting}$): Because the natural baseline formation of highly stable pyrogenic carbon is zero, and the activity shall pass the regulatory-surplus / BAU screen to be eligible, the final Crediting Baseline Removals shall be the higher of the Unadjusted Baseline and the conservative BAU removal.

$$BR_{crediting,y} = MAX\left(BR_{unadj,}BR_{BAU,y}\right) \qquad \text{Eq 4}$$

Where;

Parameter	Description	Value
$BR_{crediting,y}$	Final Crediting Baseline Removals (Deduction) in year y (tCO_2e)	Calculated
$BR_{unadj,}$	Unadjusted baseline removals (0)	Eq. 1
$BR_{BAU,y}$	Legally mandated removals calculated in Eq. 3	Eq. 3

8| ACTIVITY REMOVALS

8.1 | Identification of the Activity Removals

8.1.1 | The activity scenario involves the thermochemical stabilisation of biogenic carbon (biochar production) and its subsequent application in a sink that ensures durable storage (biochar application).

8.1.2 | Activity Removals (AR_y) quantify the net mass of biogenic carbon dioxide equivalent (tCO_2e) that is durably sequestered as a result of the activity during the monitoring period y.

8.1.3 | **Ineligible Volumes:** Biochar that lacks comprehensive digital Chain of Custody evidence, is utilised for energy (fuel), is lost during transport, is applied to ineligible sinks, or is exported and applied outside the Host Country jurisdiction, shall have an activity removal value of Zero (0).

8.2 | Calculation of Activity Removals

8.2.1 | The Activity Removals in monitoring period y are calculated as the total mass of stable organic carbon sequestered, adjusted for moisture, stability, application losses, and uncertainty.

$$AR_y = \sum_i \left[Q_{biochar,i,y} \times \left(1 - MC_{i,y}\right) \times C_{org,i,y} \times F_{perm,i,y} \times \left(1 - L_{app,i}\right) \times \frac{44}{12} \right] \times \left(1 - UNC_{AR}\right)$$

Eq. 5

Where;

Parameter	Description	Value
AR_y	Total activity removals during period y (tCO_2e)	Calculated
i	Batch or Continuous production lot of biochar (differentiated by feedstock/technology)	-
$Q_{biochar,i,y}$	Mass of biochar type i distributed/applied during period y (tonnes, wet basis t_{wet}).	Monitored (Section 8.3)
$MC_{i,y}$	Moisture Content of biochar type i (fraction, decimal)	Section 8.3
$C_{org,i,y}$	Organic Carbon Content of biochar type i (fraction, decimal, dry basis)	Section 8.4

$F_{perm,i,y}$	Permanence Factor: Fraction of organic carbon ($C_{org,i,y}$) remaining sequestered after the defined durability timeframe	Section 8.5
$L_{app,i}$	Application Loss Factor (Material lost during transport/application)	Section 8.6
$\frac{44}{12}$	Stoichiometric conversion factor from Carbon (C) to CO_2 (3.667)	Constant
UNC_{AR}	Aggregate Uncertainty Deduction (Track-dependent) (decimal)	Section 8.7

8.3 | Determination of Biochar Quantity and Moisture

8.3.1 | **Tracking Units:** To maintain strict chain-of-custody, production volumes shall be segregated into tracking units. A "Batch" is defined as a discrete volume of biochar produced from a homogenous feedstock in a single firing cycle (Track 1/2). A "Continuous Production Lot" is defined as the volume produced by a continuous unit (Track 2 or Track 3) over a maximum of 24 hours. A production lot shall additionally share common processing conditions: where the highest treatment temperature varies by more than 50^0C from the lot set point (Annex 4) or the feedstock category changes, a new, distinct production lot shall be started. A lot is defined by its thermochemical consistency, not by elapsed time alone.

8.3.2 | The activity developer shall determine the quantity using the method assigned to the compliance track.

8.3.2.1 | **Option A: Aggregated Weighing (Track 1)**

a | **Method 1 (Weighing):** Mass is measured at the Aggregator Hub or any authorized, calibrated weigh-station within the defined activity boundary using calibrated hanging scales or platform scales. This measured weight serves as the primary variable for quantifying Activity Removals.

b | **Method 2 (Back-calculation of dry biomass input (for leakage only)):** Where direct weighing of the input biomass is not practicable, the mass of dry biomass input ($Q_{biomass,dry}$) — required solely for quantifying leakage — may be back-calculated from the weighed biochar output using the Conservative Default Yield Factor ($Y_{default}$) from Annex 5. This option is not available for Module F1 field residue: the residue removed from the field shall be weighed at the collection point on the calibrated hanging or platform scale used for biochar, and the weighed dry mass used for ecological leakage under Section 10.6.

$$Q_{biomass,dry} = \frac{Q_{biochar,dry}}{Y_{default}} \qquad \text{Eq. 6}$$

Where

Parameter	Description	Value
$Q_{biomass,dry}$	Mass of dry biomass input. (t_{dry})	Calculated
$Q_{biochar,dry}$	Mass of dry biochar output (weighed). (t_{dry})	Monitored
$Y_{default}$	Conservative Default Yield Factor (0.15 for all Track 1 feedstock classes). (Fraction)	Annex 5

c | **Mass Balance Safeguard:** Regardless of the method, where the calculated yield (Q_{char}/Q_{bio}) exceeds the feedstock-specific maximum yield in Annex 5 (Table 20), the affected batch is quarantined and excluded from crediting until the discrepancy is reconciled. Where the feedstock class is not listed in Table 20, the batch is ineligible until a class is assigned. This biochar-yield ceiling is a mass-balance flag and is distinct from the residue-retention floor of Annex 8 (A8.5), which separately governs how much residue must remain on the field.

d | **Moisture content** (MC)**:** Determine via moisture meter or where rapid testing is unavailable, apply the conservative quench-specific default from Annex 5 (15% for air- or snuff-quenched biochar; water-quenched biochar shall be measured and has no default).

8.3.2.2 | **Option B: Direct Weighing (Track 2)**

a | **Method:** Mandatory direct weighing of biochar output batches using facility scales.

b | **Moisture** (MC)**:** Determine via onsite moisture analyser (e.g., gravimetric oven or IR sensor) per batch. Default deductions are prohibited.

8.3.2.3 | **Option C: Precision Weighing (Track 3)**

a | **Method:** Weight measured via calibrated weighbridge or industrial load cells integrated with SCADA.

b | **Moisture** (MC)**:** Determine via laboratory analysis (ISO 18134) or inline calibrated sensors.

8.4 | Determination of Organic Carbon Content

8.4.1 | The Organic Carbon Content (C_{org}) represents the sequestration potential. Total Carbon (C_{tot}) shall not be used as a proxy unless the biochar is verified to contain negligible carbonates (below 2% by mass) or total inorganic carbon is quantified and subtracted (Annex 4).

8.4.1.1 | **Track 1 & 2: Composite Sampling**

a | **Method:** Physical sub-samples shall be collected from every batch. A minimum of six sub-samples shall be collected per batch. These are mixed to form a Composite Master Sample representing a maximum of 50 tonnes or 1 calendar month of production (whichever is sooner) for Track 1, and a maximum of 100 tonnes or 1 calendar month of production (whichever is sooner) for Track 2.

b | **Analysis:** The Master Sample is analysed by an accredited lab.

c | **Default (Track 1; Track 2 where selected):** Where the host country lacks a laboratory that is either accredited under ISO/IEC 17025 or authorised by the relevant government authority, the activity may use the tiered conservative default C_{org} from Annex 5 (Table 21: 0.55 for woody biomass and for nutshells, stones and pits; 0.45 for herbaceous residues and bagasse; 0.35 for rice husk and high-silica husks). Manure and biosolids (Module F6) are Track 3 feedstocks and are measured. Track 1 activities may alternatively apply the correlated ash proxy of Section 15.5 where calibrated.

8.4.1.2 | **Option B: Batch Analysis (Track 3)**

a | **Method:** Every production lot or continuous run (24h) is sampled and analysed individually by an ISO 17025 accredited laboratory or via continuously cross-calibrated proximate analysis (Annex 4).

8.5 | Determination of the Permanence Factor

8.5.1 | The Permanence Factor represents the fraction of organic carbon that remains sequestered in the soil or matrix after the defined durability timeframe. For Module A2 (Engineered Materials), a Permanence Factor of 0.95 applies. No 1,000-year durability claim is available under Module A2. The Permanence Factor is separate from the reversal-risk deduction under Sections 11.5 and 12.2 and shall not be applied more than once. Module A3 (Earth Vaults) remains subject to the anoxic-storage Permanence Factor and breach treatment in Method 3 below.

8.5.2 | **Method 1: Soil Decay Model (200-Year Durability)**

8.5.2.1 | **Applicability**: Applicable to all Tracks for biochar with a molar $H{:}Corg$ ratio not exceeding 0.5 (Track 2 and Track 3) or 0.4 (Track 1, where measured; the track 1 default route credits at the 0.40 column) claiming standard 200-year durability. Biochar with a molar $H{:}Corg$ ratio above 0.5 is not eligible under this decay pathway and may be credited only under Method 2 (inertinite petrography; 0.5 < H:Corg ≤ 0.7; Tracks 2 and 3).

8.5.2.2 | **Method:** The Permanence Factor (F_{perm}) is the fraction of organic carbon remaining sequestered after 200 years, derived from molar $H{:}C_{org}$ and the Mean Annual Soil Temperature ($MAST$, 0-30 cm) of the application site using permanence factors tabulated in Annex 6 (Table 24).

a | **MAST input for all Track 2 and Track 3:** MAST shall be the value at the centroid of the application boundary obtained from a recognised global gridded dataset (e.g. NASA POWER, ISRIC SoilGrids, or ERA5-Land), fixed at Design Certification for the crediting period, rounded UP to the next whole degree and not taken below the 7°C calibration floor of Annex 6. Track 1 activities may instead apply the conservative default MAST of 25 °C without site measurement.

b | **Track 2 and Track 3 (measured $H{:}C_{org}$):** F_{perm} shall be determined from measured molar $H{:}Corg$ and the site MAST $F_{perm}H{:}C_{org}$ using Annex 6, Table 24, at the tabulated ratio or, where the ratio falls between columns, at the next higher tabulated column. The organic-carbon content used to derive the ratio shall be taken at the lower bound of its 95% confidence interval.

c | **Track 1 (default factors):** F_{perm} shall be from Annex 6 (Table 24) at a molar $H{:}Corg$ of 0.40 and the Track 1 default MAST of 25 °C, giving F_{perm} = 0.754, subject to the Track 1 $H{:}C_{org}$ requirement and default factor corroboration of Section 3.2. A Track 1 activity that evidences a lower site MAST from a recognised gridded dataset may use the corresponding higher-permanence row.

$$F_{perm} = Lookup(H{:}C_{org}, MAST) \qquad \text{Eq 7}$$

Where

Parameter	Description	Value
F_{perm}	Permanence Factor (200-year stability). Fraction	$H{:}Corg$ Annex 6, Table 24
$H{:}C_{org}$	Molar Hydrogen to Organic Carbon ratio. Ratio	Lab Analysis
$MAST$	Mean Annual Soil Temperature (0–30 cm depth). ^{0}C	Global dataset (Track 2/3); 25 °C default (Track 1); 7 °C floor

8.5.3 | Method 2: Inertinite Petrography (High Durability; 1000 Year)

8.5.3.1 | **Applicability:** Optional for Track 2 and 3, Module A1 only; Modules A2 and A3 apply Method 3) for activities that select to claim 1,000 years high durability. It is not required for eligibility; the default durability route is the 200-year H:C_org decay model (Method 1), available to all Tracks. Biochar with 0.5 < H:Corg ≤ 0.7 is creditable only via Method 2 (R_0 ≥ 2%)

8.5.3.2 | **Method:** Where selected, the inertinite fraction shall be determined by random-reflectance petrography (R_o ≥ 2 %) per (Sanei et al., 2024), and credited as the product of the inertinite fraction and the non-reactive carbon fraction, each taken as its mean less one sample standard deviation across at least three replicate samples of at least 500 reflectance point-counts, capped at 0.95 (Annex 4).

$$F_{perm,i} = MAX(0, MIN(0.95, (R_0 - sR_0) \times (Cnon-reactive - sC))) \qquad \text{Eq 8}$$

Where

Parameter	Description	Value
$F_{perm,i}$	Permanence factor for high Durability. (Fraction)	Calculated
$\%Intertinite_{org}$	Inertinite fraction (R_o) ≥ **2%,** mean less one standard deviation	Lab Analysis (Annex 4)

8.5.4 | **Method 3: Anoxic and Encapsulated Storage (Module A2 & A3):**

8.5.4.1 | **Applicability:** Applicable to biochar permanently isolated from biological soil oxidation: encapsulated in non-porous engineered materials (Module A2), or placed in sealed Dedicated Earth Vaults. subterranean or above-ground (Module A3; Section 3.2.11 |). A fixed Permanence Factor of 0.95 applies, provided the physical-integrity safeguards in Section 12 are met. Module A3 is appropriate for contaminated biochar, for contexts where soil application is unsuitable, or where durable inert storage is the chosen route; clean, agronomically valuable biochar should preferentially be applied to soil (Module A1).

8.5.4.2 | The Activity Developer shall demonstrate via engineering reports that the biochar is stored in a sealed environment with an impermeable liner and sealed cap meeting the technical requirements of Annex 3 (Module A3), with a hydraulic conductivity not exceeding 1×10^{-9} m/s, that effectively halts oxidation.

8.5.4.3 | **Breach condition:** If the vault cap integrity is breached during the durability monitoring period and not repaired within 30 days, the Permanence Factor shall revert to the default Soil Decay Model (Method 1) based on the local temperature (MAST), and the difference shall be treated as an Avoidable Reversal.

8.6 | Application Loss Factor

8.6.1.1 | A deduction is applied to account for biochar mass lost (fugitive dust, wind, spillage) during transport and application. These represent untracked upfront removals excluded for conservativeness, not reversals. Where the credited biochar mass is weighed at the point of placement, or at intake to the encapsulation plant or vault, under the chain-of-custody record of Section 15, the measured mass is credited and the application loss factor is zero; biochar weighed earlier and not placed is excluded from the credited mass.

Table 9. Application Loss Factors:

End-Use Module	Application context	L_{app} Value	Justification
A1: Soil	Mechanised surface incorporation	0.05 (5%)	Standard loss during broad spreading and mechanised tilling
A1: Soil	Precision manual placement (any Track)	0.02 (2%)	Precision manual placement (e.g., planting pits, root-zone injection). shall be photographically verified.
A2: Engineered Materials	Industrial Encapsulation	0.01 (1%)	Conservative discount for spillage/dust during transit and

			mixing at the batch plant prior to encapsulation.
A3: Anoxic Storage	Earth Vaults	0.01 (1%)	Minimal loss during bulk tipping/compaction; closed dedicated system.

8.7 | Uncertainty Deduction:

8.7.1 | The total Activity Removals shall be adjusted for uncertainty based on the precision of the MRV system.

Table 10. Uncertainty Factors (UNC_{AR})

Compliance Track	UNC_{AR}	Conditions
Track 1 (Distributed)	0.05 (5%)	The Annex 5 defaults for yield, carbon content and moisture are set at conservative bounds, but the weighed biochar mass is measured on hanging or spring scales calibrated monthly and is not covered by any default. A 5% deduction applies.
Track 2 (Mechanised)	0.05 (5%)	Fixed deduction to account for variance in Composite Sampling limits and basic platform scale precision; a calculated value may be elected per parameter under Section 13.1.
Track 3 (Industrial)	Calculated	Based on error propagation of Mass Measurement (Scale Precision Error) and Lab Sampling variance at a 95% Confidence Interval. • If Total Error $\leq 1\%$, $UNC_{AR} = 0$. • If Total Error $> 1\%$, deduct the excess percentage.

9| ACTIVITY EMISSIONS

9.1 | Identification of the Activity Scenario

9.1.1 | Activity Emissions (AE_y) represent the total GHG emissions associated with the implementation of the project activity during the monitoring period y. The Activity Developer shall quantify emissions from the following sources identified in the Activity Boundary:

a | **Biomass Supply** (AE_{supply}): Cultivation (Module F5 only) and pre-processing and wet-feedstock storage methane (Section 9.3).

b | **Biochar Production** (AE_{prod}): Energy use and Methane Slip (CH_4) from pyrolysis.

c | **Transportation** (AE_{trans}): Logistics for feedstock and biochar, and laboratory samples.

d | **Application** (AE_{app}): Machinery used for soil or material application.

e | **Soil disturbance:** mineralisation of soil organic carbon where incorporation requires deep tillage of no-till or perennial land (Equation 19). Embodied emissions of production equipment are accounted as leakage under Section 10.4.

9.1.2 | **Significance and Materiality:** Individual emission sources representing < 2% of the total estimated activity emissions (e.g., off-site cloud computing for general data hosting) may be omitted, provided the sum of all omitted sources does not exceed 5% of the total (AE_y).

9.1.2.1 | **Exception:** Methane (CH_4) emissions from the pyrolysis reactor and N_2O from fertiliser use (Module F5) are deemed significant and shall never be omitted.

9.1.2.2 | **Digital MRV Materiality:** Electricity consumption from onsite SCADA systems, CEMS equipment, and local facility server infrastructure shall be metered and included.

9.2 | Calculation of Total Activity Emissions

9.2.1 | The total Activity Emissions in monitoring period y (AE_y) shall be calculated as the sum of all component sources, adjusted for uncertainty:

$$AEy = (AEsupply,y + AEprod,y + AEtrans,y + AEapp,y) \times (1 + UNCAE)$$

Eq. 9

Where

Parameter	Description	Section
AE_y	Total Activity Emissions in period y.(tCO_2e)	Calculated
$AE_{supply,y}$	Emissions from biomass supply and pre-processing. (tCO_2e)	Sec 9.3
$AE_{prod,y}$	Emissions from biochar production operations. (tCO_2e)	Sec 9.4
$AE_{trans,y}$	Emissions from transportation. (tCO_2e)	Sec 9.5
$AE_{app,y}$	Emissions from biochar application. (tCO_2e)	Sec 9.6
UNC_{AE}	Aggregate Uncertainty Factor for Activity Emissions. (decimal)	Sec 9.7

9.3 | Emissions from Biomass Supply

9.3.1 | Emissions from biomass supply include the energy used for pre-processing (chipping, drying) and, for Purpose-Grown biomass, the emissions from cultivation. Where wet feedstocks (for example manure, sludge, pomace or fresh agricultural residues) are stored in piles prior to processing, the CH_4

emissions from anaerobic decay during that storage shall be quantified under Equation 10 and included in the biomass supply emissions as $AE_{storage,y}$ (Equation 11, where $AE_{storage,y}$ is the feedstock-storage methane of Equation 10, tCO_2e).

$$AE_{storage,y} = \sum_{lots} M_{dry,l} \times C_{frac,l} \times 0.0013 \times \frac{16.04}{12.01} \times GWP_{CH4} \times max(0, months_l - 1) \quad \text{Eq 10}$$

Where:

Parameter	Description	Source
$AE_{storage,y}$	Methane emissions from anaerobic decay of wet feedstock stored in piles before processing, in year y (tCO2e)	Calculated
$M_{dry,l}$	Bone-dry mass of feedstock lot l (t)	Monitored
$C_{frac,l}$	Carbon fraction of lot l (t C/t dry)	Laboratory analysis
$months_l$	Storage duration of lot l, rounded up to whole months	Monitored
GWP_{CH4}	Global warming potential of methane (28; IPCC AR5, 100-year)	PARC 1
0.0013	Fraction of stored carbon lost as methane per month beyond the first	Methodology default

$AE_{storage,y}$ is zero where any of the following is evidenced: storage of one month or less; feedstock moisture of 30% or less on a wet basis; coarse woody material above 10 cm diameter; pelletised feedstock; or storage conditions unchanged from the counterfactual. For Module F6 feedstock (manure, digestate or sewage sludge) stored wet before pyrolysis, the default rate shall not be used; $AE_{storage,y}$ shall be quantified under the activity-specific route using the methane conversion factor for the storage system in the 2019 Refinement to the 2006 IPCC Guidelines, Volume 4, Chapter 10.

$$AE_{supply,y} = AE_{pre-proc,y} + AE_{storage,y} + AE_{cultivation,y} \quad \text{Eq. 11}$$

Where

Parameter	Description	Value
$AE_{pre-proc,y}$	Total pre-processing Emissions in period y.(tCO_2e)	Calculated
$AE_{cultivation,y}$	Total emissions associated with cultivation in period y.(tCO_2e)	Calculated

9.3.2 | **Pre-Processing ($AE_{pre-proc,y}$):** Applies to All Feedstock Modules (F1–F6). Includes emissions from electricity (grid/off-grid) and fossil fuels (e.g., diesel chippers) used to prepare biomass.

$$AE_{pre-proc,y} = \sum_j (FC_{proc,j,y} \times NCV_j \times EF_{fuel,j}) + (EC_{pre-proc,y} \times EF_{grid,y}) \quad \text{Eq. 12}$$

Where

Parameter	Description	Value
$FC_{proc,j,y}$	Quantity of fuel type j consumed for pre-processing in period y. (Mass/Volume)	Metered/Invoices
NCV_j	Net Calorific Value of fuel type j (TJ/unit)	National or IPCC default
$EF_{fuel,j}$	Emission factor for fuel type j (tCO_2e/TJ)	Tool 01
$EC_{pre-proc,y}$	Quantity of electricity consumed for processing. (MWh)	Metered
$EF_{grid,y}$	Grid Emission Factor for the Host Country.tCO_2e/MWh	A6.4-AMT-007 applied with TOOL 10

9.3.2.1 | **Track 1 Exemption:** Manual processing (e.g., sun drying, hand chopping) is deemed Zero. Small-scale electric shredders used in Aggregated Hubs shall be accounted for.

9.3.2.2 | Track 1 and Track 2 activities may, in place of metering fuel consumption and grid electricity for small hub-level processing equipment (e.g. shredders, chippers), apply the conservative default pre-processing emission factor (per tonne of biomass processed) specified in Annex 5. This option is available only to equipment within the definition of a "small processing hub" set out in Section 2 and Annex 5 (at or below 15 tonnes of feedstock per day); a hub exceeding that threshold shall meter consumption directly.

9.3.3 | **Cultivation:**

9.3.3.1 | **Modules F1, F2, F3, F4, F6 (Waste, Residues and Restorative Residues)**: $AE_{cultivation,y} = 0$. These are residues or waste streams; upstream production emissions are allocated to the primary product (e.g., grain) or waste generator.

9.3.3.2 | **Module F5 (Purpose-Grown):** Mandatory Inclusion. The activity developer shall calculate the full lifecycle emissions of cultivation (N_2O from fertiliser, CO_2 from farm machinery) using PACM or *CDM Tool 16: Project and leakage emissions from biomass*. See Annex 8 (A8.8.3).

9.3.3.3 | To prevent double-counting of removals, biomass whose biogenic carbon is credited as a GHG removal under another activity ((for example, an afforestation/reforestation or soil-carbon activity crediting the sequestered carbon) is ineligible as feedstock under this methodology, unless that activity verifiably relinquishes or cancels the corresponding removal claim for the biomass concerned.

9.4 | Emissions from Biochar Production

9.4.1 | This component captures auxiliary energy use and the critical source of Methane Slip (uncombusted pyrolysis gases). In addition, where biomass, biogas or bio-oil is combusted to provide auxiliary process heat, the CH_4 and N_2O emissions arising from that combustion shall be quantified and included (the biogenic CO_2 remaining excluded); and N_2O arising from incomplete combustion during thermochemical conversion shall likewise be included where detected by a Continuous Emissions Monitoring System.

$$AE_{prod,y} = AE_{energy,y} + AE_{CH4,y} \qquad \text{Eq. 13}$$

Where

Parameter	Description	Value
$AE_{prod,y}$	Activity emissions from production of biochar in period y (tCO_2e)	calculated
$AE_{energy,y}$	Activity emissions due to auxiliary energy use during biochar production (tCO_2e)	calculated
$AE_{CH4,y}$	Activity emissions due to methane emissions from incomplete combustion (tCO_2e)	calculated

9.4.2 | **Auxiliary Energy ($AE_{energy,y}$)**: Includes emissions from startup fuels (LPG/Diesel) and metered electricity for fans, automation, SCADA systems, and CEMS hardware. (Note: Sustained fossil fuel use for pyrolysis is prohibited). (Note: Variables mirror Equation 12 but are specifically tracked for the pyrolysis production phase).

$$AE_{energy,y} = \sum_j \left(FC_{prod,j,y} \times NCV_j \times EF_{fuel,j}\right) + \left(EC_{prod,y} \times EF_{grid,y}\right) \qquad \text{Eq. 14}$$

Where:

Parameter	Description	Source
$AE_{energy,y}$	Emissions from auxiliary energy used in production in year y (tCO_2e)	Calculated
$FC_{prod,j,y}$	Quantity of fuel j consumed for start-up and auxiliary use in year y (mass or volume)	Monitored
NCV_j	Net calorific value of fuel j (TJ per unit)	TOOL 1
$EF_{fuel,j}$	CO_2 emission factor of fuel j (tCO_2/TJ)	TOOL 1
$EC_{prod,y}$	Metered electricity consumed by the production unit in year y (MWh)	Monitored
$EF_{grid,y}$	Emission factor of the electricity consumed (tCO_2/MWh)	A6.4-AMT-007 with TOOL 10

9.4.2.1 | **Track 1:** deemed Zero where no electricity is used; fossil start-up fuel is not permitted (Section 3.2.4 |).

9.4.3 | **Methane Slip ($AE_{CH4,y}$):** The activity developer shall calculate methane emissions based on the specific Compliance Track and technology performance.

9.4.3.1 | **Track 1 Option A: (Conservative Default):** Track 1 activities shall apply the methane emission factor ($EF_{CH4,tech}$) for the kiln technology and feedstock moisture class in Annex 5, Table 22. Feedstock moisture is measured at charging on a wet basis with a calibrated handheld meter and recorded for every batch:

a | where the feedstock moisture at charging is 15% or less, the dry-class factor applies; where it is above 15% and at most 24%, the semi-moist-class factor applies;

b | where the feedstock moisture is above 24% or more, the batch is not creditable; the feedstock shall be dried to 24% or less before charging.

9.4.3.2 | **Track 1 Option B: Activity-specific methane factor**: A Track 1 activity may establish its own methane emission factor for a kiln type and feedstock class, in place of the Table 22 default or where Table 22 provides none, subject to all of the following:

a | the factor is the mean plus one standard deviation of the measured batches and is never lower than the Table 22 default for the moisture class, or 5 g CH_4 per kg dry biochar where there is no default;

b | measurement is made by an independent party using a published field method for open kilns (hood or tracer-ratio sampling) on at least ten batches drawn from at least three production units, with feedstock moisture recorded for every batch;

c | the factor applies only to the kiln type, feedstock class and moisture class measured;

d | the factor is corroborated by a further measurement set at least annually — a higher result replaces it from the next monitoring period, a lower result does not replace it until two consecutive annual sets agree;

e | the measurement report and data are submitted with the monitoring report and verified;

f | where the activity changes kiln design, feedstock source or drying practice, the factor lapses and the default applies until it is re-established.

$$AE_{CH4,y} = Q_{biochar,y} \times EF_{CH4,tech} \times GWP_{CH4} \qquad \text{Eq 15}$$

Where

Parameter	Description	Source
$Q_{biochar,y}$	Quantity of biochar produced (dry basis).(t)	Monitored

$EF_{CH4,tech}$	Methane emission factor by kiln technology and feedstock moisture class (wet basis): flame-curtain kiln 0.0055 (≤ 15%), 0.020 (>15% to 24%); above 24% not creditable; TLUD by activity-specific factor (Option B)	Annex 5
GWP_{CH4}	Global Warming Potential of methane (28; IPCC AR5, 100-year)	IPCC

9.4.3.3 | **Track 2: (Thermal Proxy Monitoring):** Track 2 activities utilising mechanised retorts with a Secondary Combustion Chamber (SCC) or Thermal Oxidizer calculate emissions based on the continuity of the destruction temperature.

a. **Compliant State:** where the SCC temperature is continuously verified as $(T_{SCC}) \geq 850^0$C and residence time ≥ 2s, methane slip is deemed effectively zero.

b. **Excursion State:** If the thermal proxy fails, the worst-case Penalty Factor from Annex 5 shall be applied to all biochar produced during the excursion window. This penalty is applied in addition to the Track 2 uncertainty deduction of Table 16; it does not replace or reduce the 2.5% minimum reversal-risk rate under Section 11.5.

$$AE_{CH4,y} = Q_{non-compliant,y} \times EF_{CH4,penalty} \times GWP_{CH4} \quad \text{Eq. 16}$$

Where

Parameter	Description	Source
$Q_{non-compliant,y}$	Quantity of biochar produced during periods where residence time is below 2s or $T_{SCC} < 850^0$C (t)	Datalogger
$EF_{CH4,penalty}$	Conservative Penalty Factor for retorts without oxidation (Default: 0.15). tCH_4 per t dry biochar	Methodology Default
GWP_{CH4}	Global Warming Potential of methane (28; IPCC AR5, 100-year)	IPCC

9.4.3.4 | **Track 3 (Direct Measurement):** Track 3 activities shall use Continuous Emissions Monitoring Systems (CEMS) to measure actual CH_4 concentration in the flue gas.

$$AE_{CH4,y} = \sum_t \left(Conc_{CH4,t} \times Vol_{gas,t} \times 10^{-9}\right) \times GWP_{CH4} \quad \text{Eq. 17}$$

Where

Parameter	Description	Source
$Conc_{CH4,t}$	Concentration of CH4 at time t. (mg/m3)	Datalogger

$Vol_{gas,t}$	Stack gas volume at time t.m3	Flow Meter
10^{-9}	Conversion factor from milligrams (mg) to metric tonnes (t).	Constant
GWP_{CH4}	Global Warming Potential of methane (28; IPCC AR5, 100-year)	GS4GG

9.5 | Transportation Emissions

9.5.1 | Includes emissions from the transport of biomass (Source to Production) and biochar (Hub to Application), and the shipment of physical biochar samples to external laboratories for testing including the return trips.

$$AE_{trans,y} = \sum_k \left(Dist_k \times Mass_k \times EF_{trans,k}\right) \quad \text{Eq. 18}$$

Where

Parameter	Description	Source
$Dist_k$	Distance per trip k (return included if empty; includes relocation of a mobile or modular production unit between registered sites).km	Monitored
$Mass_k$	Weight of payload per trip k.(t)	Monitored
$EF_{trans,k}$	Emission factor for vehicle type k. (tCO_2e/tkm)	Emissions from Freight Transport (GS TOOL2/CDM TOOL12 until superseded)

9.6 | Application Emissions

9.6.1 | Includes emissions from machinery used to apply biochar (e.g., tractors, spreaders, concrete mixers, excavators for earth vaults) and potential soil carbon losses.

$$AE_{app,y} = \sum_j \left(FC_{app,j,y} \times NCV_j \times EF_{fuel,j}\right) + AE_{SOC-loss,y} \quad \text{Eq. 19}$$

Where:

Parameter	Description	Source
$AE_{app,y}$	Emissions from the application of biochar in year y (tCO_2e)	Calculated
$FC_{app,j,y}$	Quantity of fuel j consumed by application machinery in year y	Monitored
NCV_j	Net calorific value of fuel j (TJ per unit)	TOOL 1
$EF_{fuel,j}$	CO_2 emission factor of fuel j (tCO_2/TJ)	TOOL 1

Parameter	Description	Source
$AE_{SOC-loss,y}$	Soil organic carbon mineralised where incorporation requires deep tillage of no-till or perennial land (tCO_2e)	Annex 8 (A8.7.4)

9.6.1.1 | **Machinery Emissions**:

a | **Manual Application:** If biochar is applied manually by hand (Track 1), the machinery term of Equation 19 is zero.

b | **Mechanical Application**: The activity developer shall calculate actual diesel consumption using operational logs ($FC_{app,j,y}$) or utilise verified, conservative regional average factors specific to the exact machinery used (e.g., standard agricultural tractors vs. heavy earthmoving equipment).

9.6.2 | **Soil Disturbance Penalty:** To maintain strict CDR boundaries, any counterfactual avoided soil N_2O emissions post-application shall not be credited. However, if the incorporation of biochar (Module A1) requires mechanical tillage deeper than 30 cm on verifiable no-till agriculture or perennial grasslands, the resulting pulse of mineralised SOC shall be quantified as an application emission under Equation 19, using the soil-disturbance provision of Annex 8 (A8.7.4). It is not deducted again under Section 10.6.

9.7 | Uncertainty Accounting for Activity Emissions

9.7.1 | Activity emissions shall be adjusted for uncertainty depending on the MRV approach used.

a | **Track 1 (Defaults):** $UNC_{AE} = 0.05\ (5\%)$. A fixed deduction of 5% applies (Table 16).

b | **Track 2 (Proxy/Simplified)**: $UNC_{AE} = 0.05\ (5\%)$. A fixed deduction of 5% applies (Table 16), or the calculated value where the Track 2 election of Section 13.1 is made. During a thermal excursion the 0.15 penalty factor applies in place of the proxy.

c | **Track 3 (Precision):** $UNC_{AE} = Calculated$. Uncertainty is determined by the instrument precision ($\pm$ error) of the CEMS and metering equipment at a 95% Confidence Interval. Utility-invoiced energy consumption is deemed to have zero measurement uncertainty. If the aggregate uncertainty is 5% or less, no deduction applies; above 5%, the excess over 5% is applied (Section 13.3, Equation 34)

10| LEAKAGE EMISSIONS

10.1 | Identification of Leakage Sources

10.1.1 |Leakage is defined as the net change of anthropogenic GHG emissions occurring outside the activity boundary that is attributable to the activity. The activity developer shall apply the stepwise approach defined in GS4GG PAA MS400-05 to Identify, Minimise, and Quantify leakage emissions.

10.1.2 | Where the net calculated leakage effect would be beneficial — that is, a net reduction in emissions or a net increase in removals occurring outside the activity boundary — the leakage term shall be set to zero for conservativeness, and such beneficial effects shall not be credited. For the avoidance of doubt, negative leakage as defined in GS4GG PAA MS400-05 Leakage requirements (an increase in emissions, or a decrease in removals, outside the activity boundary attributable to the activity) is an adverse effect; where it occurs it shall be quantified and deducted.

10.1.3 | The activity developer shall identify potential leakage sources based on the selected Compliance Track and Feedstock Module using the table below.

Table 11. Sources of Leakage Emissions

Source	Description	Module Relevance	Inclusion Requirement
Embodied Emissions	**Cradle-to-gate emissions** associated with the manufacturing and transport of biochar production equipment (e.g., steel kilns, industrial plants) and facility construction.	All Tracks	**Mandatory.** • **Track 1 and Track 2:** Standardised Default. (Section 10.4, Option A). • **Track 3:** LCA Deduction, amortised in equal annual amounts over the first crediting period (Section 10.4, Option B).
Market Leakage	**Biomass Diversion:** Non-participants who previously used biomass (e.g., for fodder, fuel) switch to fossil fuels or non-sustainable resources due to supply diversion.	All feedstock modules (principally F1, F2)	**Mandatory.** Mitigated via "Surplus Test (Annex 8 A8.4)" If fails, emissions shall be quantified.
Ecological Leakage	**Nutrient & SOC Displacement:** Removal of crop residues (F1) depletes soil nutrients (N-P-K) and halts natural Soil Organic Carbon (SOC) accumulation.	F1	**Mandatory.** • **Track 1 & 2:** Conservative Default Factors. • **Track 3:** Calculated from the measured N, P and K content (Section 10.6, Equation 23a).
Activity Shift	**Land Use Change:** Displacement of agricultural production to other lands due to the cultivation of purpose-grown biomass.	F5	**Mandatory.** Restricted to Track 3. Eligibility and iLUC treatment per Annex 8 A8.8: where the A8.8.2 land condition is met,

	LE_{shift} = 0; otherwise F5 is ineligible.

10.2 | Avoidance and Minimisation Strategies

10.2.1 | **Minimising Market & Ecological Leakage:**

10.2.1.1 | The logic governing the "Surplus Test" (to prevent market diversion to fossil fuels) and sustainable extraction rates (to prevent ecological depletion) are governed by Annex 8 (A8.4, A8.5).

10.2.2 | **Minimising Activity Shifting**

10.2.2.1 | For Module F5, the activity shall demonstrate that the land utilised for biomass cultivation is Degraded or Marginal. Leakage is deemed Zero where the land condition of Annex 8 (A8.8.2) is met, evidenced as follows:

a | Remote sensing data (e.g., NDVI Land Use Change analysis) or Participatory Rural Appraisals verifying that the land was degraded or marginal and was not in productive agriculture or grazing use on or after 31 December 2020 and before the start of the activity. The evidence shall cover the relevant land parcel and be updated whenever the parcel is materially added or changed. This fixed reference date replaces any rolling 3-year or 10-year prior-use test.

10.3 | Calculation of Total Leakage Emissions

10.3.1 | Leakage sources that cannot be avoided shall be quantified and deducted from the Net GHG Removals.

10.3.2 | Total leakage emission (LE_y) is calculated as follows

$$LE_y = (LE_{Embodied,y} + LE_{Market,y} + LE_{eco,y} + LE_{shift,y}) \times (1 + UNC_{LE}) \quad \text{Eq. 20}$$

Where

Parameter	Description	Section
LE_y	Total Leakage Emissions in period y.	
$LE_{Embodied,y}$	Embodied emissions in year y	10.4
$LE_{Market,y}$	Emissions from Market Leakage (Biomass Diversion). (tCO_2e)	
$LE_{eco,y}$	Emissions from Ecological Leakage (Nutrient Displacement). (tCO_2e)	
$LE_{shift,y}$	Emissions from Activity Shifting (Land Use). (tCO_2e)	
UNC_{LE}	Aggregate uncertainty factor for leakage (fraction): 0 where the default factors of Annex 8 and Table 12 are applied; 0.15 where a site-specific (Option B) value is used (Table 16).	Section 10.8 |; Section 13.2 |

10.4 | Embodied Emissions

10.4.1 |The activity shall account for the upstream emissions associated with manufacturing and construction of the production facility infrastructure.

10.4.1.1 |**Option A: Standardised Deduction (Track 1, 2):** A fixed deduction per tonne of biochar is applied to account for the steel/materials of the kiln. The factor is applied to the biochar produced in each year of the first crediting period only; no embodied deduction applies in a renewed crediting period unless the production unit is replaced.

$$LE_{Embodied,y} = Q_{biochar,y} \times EF_{embodied,default} \qquad \text{Eq. 21}$$

Where

Parameter	Description	Value
$EF_{embodied,default}$	Conservative default for embodied emissions. (tCO_2e per t dry biochar)	0.02 (Track 1) 0.05 (Track 2)

10.4.1.2 |**Option B: Life Cycle Assessment**: Track 3 facilities shall, and Track 1 and Track 2 activities may, determine embodied emissions from a cradle-to-gate inventory of the production unit: the mass of steel, concrete and other materials evidenced by manufacturer specification or weighbridge record, multiplied by the material emission factors from a recognised life-cycle database or published national factors, and amortised in equal annual amounts over the first crediting period. An activity applying Option B shall apply it to every production unit in the activity.

$$LE_{Embodied,y} = \left(\frac{Total\ LCA\ emisions}{5}\right) \qquad \text{Eq. 22}$$

10.5 | Market Leakage:

10.5.1 |**Quantification of Diverted Use Track:**

10.5.1.1 |**Option A (Track 1 &2):** If the biomass fails the Surplus Test per Annex 8, the activity shall quantify the emissions of the replacement resource. Furthermore, where the biomass fails the Surplus Test by reason of diversion from a pre-existing long-lived material use (for example construction materials or pulp and paper) or from a supply-limited bioenergy facility, the feedstock is ineligible under this methodology in accordance with the Cascading Use Principle; and where feedstock is diverted from a non-supply-limited, grid-connected bioenergy facility, the displaced generation shall be quantified and deducted as market leakage.

$$LE_{Market,y} = \sum_i (Q_{diverted,y} \times EF_{replace,i}) \qquad \text{Eq 23}$$

Where

Parameter	Description	Source

$Q_{diverted,y}$	Quantity of biomass type i diverted from valuable use (dry basis).(tdry)	Monitored
$EF_{replace,i}$	Default Emission Factor for the replaced resource. (tCO2e/tdry)	Table 12

Table 12. Default Replacement Factors ($EF_{replace,i}$)

Prior use of biomass	Assumed replacement	Factor (tCO_2e / t dry biomass)
Boiler or kiln fuel — woody biomass	Coal or non-renewable wood	1.75
Boiler or kiln fuel — herbaceous residue	Coal or non-renewable wood	1.30
Household cooking fuel — woody biomass (where LPG is the demonstrated replacement)	LPG	0.27
Household cooking fuel — herbaceous residue (where LPG is the demonstrated replacement)	LPG	0.20
Animal fodder, bedding or mulch	No default	Site-specific calculation (Option B)

10.5.1.2 | **Option B: Specific Analysis**: Any activity may, and an activity using fodder, bedding or mulch feedstock shall, calculate a site-specific replacement factor based on the actual alternative fuel/feed used by the displaced consumers (e.g., LPG substitution), using standard calorific and emission factors.

10.6 | Ecological Leakage

10.6.1 | Applicable exclusively to Module F1 (Field Residues). This section accounts for the emissions associated with replacing the soil nutrients (N, P, K) exported from the farm in the biomass.

10.6.2 | **Foregone SOC & Nutrient Penalty:** The activity developer shall calculate an Ecological Leakage deduction encompassing both the emissions required to synthetically replace exported soil nutrients (N, P, K) AND the mathematical penalty for halting the natural accumulation of foregone Soil Organic Carbon (SOC). The deduction is quantified with Equation 23a using the default factors of Annex 8 (Table 31 and Table 31a).

10.6.3 | The ecological-leakage deduction applies according to the alternative fate of the residue determined under Annex 8 (A8.3). Where the residue would have been retained on or incorporated into the field, the foregone-SOC component

and the nitrogen, phosphorus and potassium components apply. Where it would have been burned on the field, only the phosphorus and potassium components apply. Where it would have been removed from the field and dumped, piled or burned elsewhere, no ecological-leakage deduction applies. The fate determination shall be evidenced as required by A8.3 and verified.

10.6.4 | **Same-field return.** Where the biochar produced from Module F1 residues is demonstrably applied to the same land from which those residues were removed, the nutrient-replacement component attributable to phosphorus and potassium may be reduced or waived, in proportion to the verified mass of biochar returned, as these nutrients are substantially retained in the biochar and thereby returned to the soil. The nitrogen-replacement component shall be retained in full, as nitrogen is substantially volatilised during pyrolysis and is not returned. The foregone-SOC penalty shall be retained in full: the organic carbon in the biochar is credited as the Activity Removal under Section 8 and shall not additionally be counted as replacing foregone soil organic carbon.

10.6.5 | **Ecological-leakage quantification:** The deduction is calculated with Equation 23a. Track 1 and Track 2 activities apply the default nutrient contents of Annex 8, Table 31a, and the default factors of Table 31; Track 3 activities use the measured nitrogen, phosphorus and potassium content of the exported residue (composite sample per monitoring period, ISO 17025 laboratory) with the factors of Table 31.

$$LE_{eco,y} = \sum_i Q_{res,i,y} \times \left[\delta_{SOC,i} \times F_{SOC} + \delta_{N,i} \times N_i \times EF_N + \left(1 - f_{same,i}\right) \times P_i \times EF_P + K_i \times EF_k\right] \quad \text{Eq 23a}$$

Parameter	Description	Unit	Source
$LE_{eco,y}$	Ecological leakage in monitoring period y	tCO_2e	Calculated; enters Eq 20
$Q_{res,i,y}$	Dry mass of Module F1 residue of class i removed from the field in period y; taken as 0 where the alternative fate is removal from the field (no deduction applies, Section 10.6.3 |)	t dry residue	Monitored (weighed at collection, §8.3)
$\delta_{SOC,i}$	Switch for the foregone-soil-carbon term: 1 where the residue would have been retained on or incorporated into the field under Annex 8 (A8.3); 0 otherwise	—	Annex 8 alternative-fate determination
$\delta_{N,i}$	Switch for the nitrogen term: 1 where the residue would have been retained or incorporated; 0 where it would have been burned (nitrogen lost in any case)	—	Annex 8 alternative-fate determination

$f_{same,i}$	Verified share of the resulting biochar returned to the same field; applied to the P and K terms only (nitrogen is volatilised in pyrolysis and not returned)	fraction	Monitored (Section 10.6 | same-field return)
N	Nitrogen content of residue class i	t N / t dry residue	Measured (Track 3); Table 31a default (Tracks 1 and 2)
P_i	Phosphorus content as P_2O_5	t P_2O_5 / t dry residue	Measured (Track 3); Table 31a default
K_i	Potassium content as K_2O	t K_2O / t dry residue	Measured (Track 3); Table 31a default
EF_N	Nitrogen replacement emission factor	tCO_2e / t N	Table 31: 12.1
EF_P	Phosphorus replacement emission factor	tCO_2e / t P_2O_5	Table 31: 1.5
EF_k	Potassium replacement emission factor	tCO_2e / t K_2O	Table 31: 0.6
F_{SOC}	Foregone soil organic carbon per tonne of residue removed, once	tCO_2e / t dry residue	Table 31: 0.19

10.7 | Activity Shift Leakage

10.7.1 |Applicable exclusively to Module F5 (Purpose-Grown) under **Track 3**.

10.7.1.1 |**Avoidance (Degraded Land):** Leakage is deemed zero if the Activity Developer demonstrates that the land used for cultivation meets the land condition of Annex 8 (A8.8.2), including the fixed-date test (not in productive agriculture or grazing use on or after 31 December 2020).

10.7.1.2 |Where the land condition of Annex 8 (A8.8.2) is not met, the Module F5 feedstock is ineligible. No indirect-land-use-change estimate is required or accepted, and $LE_{shift,y}$= 0 for eligible Module F5 feedstock.

10.8 | Uncertainty Accounting

10.8.1 |To ensure conservativeness in estimating external effects:

10.8.1.1 |Track 1 (Defaults): $UNC_{LE} = 0$. (Default factors in Table 12 are set at conservative upper bounds).

10.8.1.2 |Track 2 & 3:

a | If using Option A (Defaults), $UNC_{LE} = 0$.

b | $UNC_{LE} = 0.15$ Where a site-specific (Option B) factor is used (Table 16).

11| NET GHG EMISSION REMOVALS

11.1 | Net Quantification Approach

11.1.1 |To ensure environmental integrity and conservativeness, the Total Activity Deductions (Activity Emissions and Leakage) shall be deducted fully against Activity Removals to ensure the Net Removal represents a true "Net-Negative" atmospheric withdrawal i.e. a net atmospheric withdrawal, having fully compensated for the project's own lifecycle footprint.

11.2 | Calculation of Total Deductions

11.2.1 |First, the activity developer shall aggregate all debit sources calculated in Sections 9 and 10.

$$Deductions_y = AE_y + LE_y \qquad \text{Eq. 24}$$

Where

Parameter	Description	Section
$Deductions_y$	Total GHG debits to be subtracted in monitoring period y.(tCO_2e)	Calculated
AE_y	Total Activity Emissions (Supply, Process, Transport, Application).(tCO_2e)	9.2
LE_y	Total Leakage Emissions (Market, Eco, Shifting). (tCO_2e)	10.3

11.3 | Calculation of Net Verified Removals and Deficit Carryover

11.3.1 |Net Verified Removals are the Activity Removals less the Crediting Baseline Removals, the Total Deductions and any carried deficit; the reversal-risk deduction (Section 11.5 |) and the DAF (Section 11.6 |) are applied to this quantity afterwards.

11.3.2 |**Emission Deficit Condition:** If the Total Deductions exceed the activity removals (i.e., $Net_{CDR,y} < 0$), the activity operated at an "Emission Deficit" for that period. Zero (0) credits shall be issued, and the exact negative mathematical balance ($Deficit_{y-1}$) shall be carried over and explicitly deducted from the $Net_{CDR,y}$ of the subsequent monitoring period.

$$Net_{CDR,y} = AR_y - BR_{crediting,y} - Deductions_y - Deficit_{y-1} \qquad \text{Eq. 25}$$

Where

Parameter	Description	Section

$NET_{CDR,y}$	Net Verified Removals (CDR) in monitoring period y (Pre-Buffer and Pre-DAF). (tCO_2e)	Calculated
AR_y	Activity Removals: Total gross durable sequestration. (tCO_2e)	8.2
$BR_{crediting,y}$	Crediting Baseline Removals (Regulatory BAU mandate). (tCO_2e)	7.6 (Equation 4)
$Deductions_y$	Total activity deductions (Emissions + Leakage). (tCO_2e)	Eq. 24
$Deficit_{y-1}$	Any negative removal balance carried over from the previous monitoring period. (tCO_2e)	Calculated

11.3.3 | Where issuance is withheld for a monitoring period solely because the NCER threshold is not met (Section 11.4), any positive Net Verified Removal balance for that period shall be recorded and carried forward. It shall be released for issuance in the first subsequent monitoring period in which $NCER_y \geq 5$, subject to the buffer and durability provisions then applying. A banked positive balance not released within three consecutive monitoring periods, by reason of continued NCER < 5, shall expire and be forfeited. A carried deficit persists until extinguished against future net removals.

11.4 | Net Carbon Efficiency Ratio (NCER) Check

11.4.1 | Before proceeding to issuance, the Activity Developer shall verify compliance with the Net Carbon Efficiency Ratio defined in Section 2 and required under Section 3.2.

11.4.1.1 | Compliance condition:

a | If $NCER_y \geq 5$: the activity is eligible for issuance.

b | If $NCER_y < 5$: The activity is inefficient for the monitoring period y. Zero (0) GSVERs shall be issued, and the positive net verified removal balance (if any) shall be banked (section 11.3) until operational efficiency improves.

c | For avoidance of doubt, the issuance condition is NCER ≥ 5 and the non-compliance condition is NCER < 5. The balance-banking treatment in this section applies only when NCER is below 5; it shall not be triggered when NCER is exactly 5. NCER is assessed for the monitoring period as a whole, across all batches, and not per batch.

$$NCER_y = \frac{Q_{biochar,dry,y} \times C_{org,y} \times \frac{44}{12}}{AE_{supply,y} + AE_{prod,y} + AE_{trans,y} + AE_{app,y}} \qquad \text{Eq. 26}$$

Where: The numerator is the carbon stored in the biochar placed in the sink during the period, before the permanence factor, application loss and uncertainty adjustments of Section 8. The denominator is the sum of the activity-emission components of Section 9 before the uncertainty adjustment of Section 9.7; leakage is excluded.

Parameter	Description	Section
$NCER_y$	Net Carbon Efficiency Ratio. (Ratio)	Calculated
AR_y	Carbon stored in the biochar placed in the sink in period y: dry mass × organic carbon content × 44/12, before the adjustments of Section 8. (tCO_2e)	8.3; 8.4
$AE_{pre-proc,y}$	Emissions from biomass supply and pre-processing. (tCO_2e)	9.3
$AE_{prod,y}$	Emissions from biochar production (Energy + Methane Slip). (tCO_2e)	9.4
$AE_{trans,y}$	Emissions from transportation. (tCO_2e)	9.5
$AE_{app,y}$	Emissions from biochar application. (tCO_2e)	9.6

11.5 | Reversal-Risk Deduction: Buffer deposit or Cancellation

11.5.1 | To manage Reversal Risks associated with non-permanent carbon storage (e.g., anthropogenic soil disturbance, demolition), the methodology applies a single reversal-risk deduction (Equation 27) at the rate determined under Section 12.2. The deduction is settled by one of two routes, according to whether the sink can be monitored for reversals, and is applied to the $NET_{CDR,y}$ volume.

a | **Buffer-deposit route (Track 2 and Track 3; Modules A1 and A3).** Activities applying biochar to monitorable sinks (contiguous agricultural land, anoxic earth vaults) shall deposit the deduction in the Gold Standard compliance buffer. For large-scale monitorable sinks (Track 2 and Track 3) the risk is addressed through the buffer contribution at the applicable rate under Section 12.2, and not additionally through a cancellation on the same tonnage. The deposited credits are drawn only to cover unavoidable reversals (Section 12.5); avoidable reversals are replaced by the activity developer.

b | **Cancellation route (Track 1 Module A1; Module A2 under Track 2 and Track 3).** Thousands of distributed smallholder plots, and biochar dispersed through concrete and asphalt, cannot be monitored for reversals over a century, so a buffer deposit for these sinks could never be drawn. The deduction for these sinks is therefore cancelled at issuance and is not deposited as an asset. The cancelled volume covers the expected long-term loss; avoidable reversals remain subject to the aggregator's strict contractual liability to replace credits. A Track 2 Module A1 activity whose biochar is applied across smallholder plots that cannot be monitored individually settles by cancellation at the Track 1 rate and applies the Track 1 Sentinel Site protocol (Section 16.3).

c | **Minimum rate:** the rate applied under Section 12.2 shall not be lower than 2.5% of the net removals, whichever route applies. The applicable rate shall be the higher of 2.5% and the rate otherwise determined under Section 12.2. Where a higher track-, end-use- or site-specific rate applies, the higher rate governs. This minimum applies once only and is separate from, and shall not be duplicated by, the Permanence Factor or another uncertainty deduction.

$$Risk_{penalty,y} = \mathrm{MAX}(0, NET_{CDR,y}) \times Rate_{risk} \quad \text{Eq. 27}$$

Where

Parameter	Description	Section
$Risk_{penalty,y}$	Quantity of credit deposited in the Buffer (buffer deposit route) or permanently cancelled (Cancellation route). (tCO_2e)	Calculated
$NET_{CDR,y}$	Net Verified Removals. (tCO_2e)	Eq. 25
$Rate_{RISK}$	Reversal Risk Rating determined by the end-use module Section 12.2 (decimal)	Section 12.2

11.6 | Application of the Downward Adjustment Factor (DAF)

11.6.1 |The activity applies a Downward Adjustment Factor ($DAF_{NetZero}$) as:

$$DAF_{deduction,y} = NET_{CDR,y} \times DAF_{Netzero,y} \quad \text{Eq. 28}$$

Where

Parameter	Description	Section
$DAF_{deduction,y}$	Quantity of credits deducted to align with Host Country Ambition. (tCO_2e)	Calculated
$DAF_{Netzero,y}$	Downward Adjustment Factor for the application Period published in the GS4GG Downward Adjustment Factor Determination Tool (i.e., 0.0125 for 2026-2030).	GS Tool MT400-05

11.7 | Final Issuable GSVERs

11.7.1 |The total quantity of Gold Standard Verified Emission Removals (GSVERs) to be issued for monitoring period y is Net Removals (net of buffer and DAF deductions).

$$ER_{total,y} = NET_{CDR,y} - RISK_{penalty,y} - DAF_{Deduction,y} \quad \text{Eq. 29}$$

Where:

Parameter	Description	Source
$ER_{total,y}$	Gold Standard Verified Emission Removals issuable for monitoring period y (tCO_2e)	Calculated
$NET_{CDR,y}$	Net removals for period y (Equation 25)	Calculated
$RISK_{penalty,y}$	Reversal-risk deduction or buffer contribution for period y (Equation 27)	Calculated
$DAF_{deduction,y}$	Downward adjustment for period y (Equation 28)	Calculated

12| REVERSALS

12.1 | Definitions and Scope

12.1.1 | **Definition of Reversal:** A Reversal is defined as the unintentional or intentional release of sequestered biogenic carbon (CO_2) back into the atmosphere prior to the expiration of the committed Durability Timeframe (200 years or 1,000 years).

a | **Excluded (Intrinsic Decline):** The gradual, biochemical oxidation of biochar in soil that naturally occurs within the bounds of the Permanence Factor (F_{perm}) calculated in Section 8 is considered "Expected Decay" and is not classified as a reversal.

b | **Included (Unexpected Loss):** Reversals refer to carbon losses in excess of the expected decay, caused by specific disturbance events (e.g., severe wildfire, combustion, excavation, demolition, cap failure).

12.1.2 | **Categories of Reversal:** The Activity Developer shall classify potential reversal events into two categories:

a | **Avoidable Reversals (Developer Liability):** Reversals arising from human intent, negligence, or mismanagement within the control of the Activity Developer (e.g., excavating biochar to sell as cooking fuel, unauthorised demolition/incineration, systematic violation of application limits or failure to repair an engineered vault cap).

b | **Unavoidable Reversals (Buffer Covered - Force Majeure):** Reversals arising from natural catastrophic events beyond human control (e.g., catastrophic high-severity wildfires that penetrate the deep root zone) or third-party acts (e.g., State expropriation of land).

12.2 | Reversal Risk Rates

12.2.1 | To manage reversal risks associated with non-permanent carbon storage, the methodology applies one reversal-risk deduction to the Net Verified Removals ($NET_{CDR,y}$), settled by buffer deposit or by cancellation as described in Section 11.5.

12.2.2 | The reversal-risk deduction ($Risk_{penalty,y}$) is calculated once, at Equation 27 (Section 11.5 |). This Section determines the applicable Reversal Risk Rate ($Rate_{risk}$) — by the fixed rates of Tables 13–14 (Option A) or, for Module A1 under Track 2 and Track 3, by the site-specific assessment of Annex 7 (Option B).

12.2.3 | **Determination of the reversal-risk rate:** the Activity Developer shall determine the rate ($Rate_{Buffer}$) using one of two options:

a | **Option A - Fixed rates**: The rates of Table 13 for Module A3 and of Table 14 for Track 1 Module A1 and for Module A2 apply without site-specific assessment.

b | **Option B - Site-Specific Risk Assessment:** For Module A1 under Track 2 and Track 3 the rate shall be determined under the Reversal Risk Assessment Tool in Annex 7. The rate may be higher or lower than the base risk of Table 13 and shall not be lower than 2.5%.

Table 13. Default Reversal Risk Rates — sinks settled by buffer deposit ($Rate_{Buffer}$)

Applicable to Track 2 and Track 3 activities with monitorable sinks (Modules A1 and A3). The deduction is deposited in the buffer (Section 11.5 |).

End-use module	Application context	Rate	Minimum floor*	Justification
A1: Soil	Track 2 & 3	Base risk 7.5%; rate determined under Annex 7	2.5%	Base risk for incorporated open-soil application under the Annex 7 tool, before site-specific additions and mitigations; monitored under Section 16.
A3: Anoxic — above-ground / raised Engineered Vault	Track 2 & 3	2.5%	2.5%	Above ground or raised: closed system, effectively permanent unless physically excavated; the greater exposure of an above-ground vault is addressed by the containment and inspection requirements of Annex 3, not by a rate premium.
A3: Anoxic — subterranean Engineered Vault	Track 2 & 3	2.5%	2.5%	Sealed, denatured, anoxic vault; residual risk is containment failure.

Note: For Module A1 the rate is the result of the Annex 7 assessment, which may be above or below the base risk, and shall not be lower than 2.5%. For Module A3 the fixed rate applies.

Table 14. Default Reversal Risk Rates — sinks settled by cancellation ($Rate_{deduction}$)

Applicable to sinks that cannot be monitored for reversals (Track 1 Module A1; Track 2 Module A1 applied across smallholder plots that cannot be monitored individually, Section 11.5; Module A2). The deduction is cancelled at issuance (Section 11.5). These rates are fixed and are not assessed under Annex 7.

End-use module	Application context	Rate / Deduction	Justification
A1: Soil	Track 1 (Distributed)	10%	Covers diversion of biochar to fuel and surface loss on dispersed plots that cannot be monitored; no replenishment route exists, so the full expected loss is cancelled. Backed by aggregator liability (Section 12.5).
A2: Materials	Concrete/Asphalt	3%	Applied in lieu of long-term demolition asset-registry tracking. Covers end-of-life demolition and accidental building fire; applied separately from the 0.95 Permanence Factor under Section 8.5, which carries the structural uncertainty.

12.3 | Mitigation and Management Measures

12.3.1 | The Activity Developer shall implement mitigation safeguards appropriate to the compliance track.

12.3.2 | **Social Permanence (Track 1 Safeguard):** The primary avoidable reversal risk for distributed activities is the diversion or intentional excavation of biochar for use as cooking fuel (charcoal). Note - Any biochar diverted, stockpiled, or sold without explicit, geo-tagged photographic proof of physical incorporation into an eligible soil sink is immediately deemed an Avoidable Reversal and is ineligible for crediting.

12.3.3 | **Physical Security (Module A2):** Contracts with off takers (e.g., concrete plants) shall stipulate that the physical biochar shall be encapsulated in non-combustible mineral matrices and that the buyer waives all rights to the carbon attribute. Biochar shall not be integrated into combustible polymers or wood-plastic composites**.**

12.3.4 | **Legal Permanence (Module A3)**: The Dedicated Earth Vault storage site shall be subject to a Legal Restrictive Covenant (or equivalent binding land-title notation) prohibiting future excavation or deep-rooting vegetation for not less than credited durability period 200 years. Where an instrument of that duration cannot be secured, Module A3 is not eligible.

12.3.5 | **Evidence regime:** Geo-tagged, time-stamped photographic proof of the physical incorporation of biochar into an eligible sink is required for every

credited batch at the point of establishing the sink; biochar without such proof is ineligible. The Sentinel Site monitoring of Section 16.3 is a separate, sample-based audit conducted during the crediting period to detect subsequent Avoidable Reversals. Both apply.

12.4 | Quantification of Reversals

12.4.1 | In the event of a confirmed reversal, the Activity Developer shall quantify the reversal tonnage using conservative damage factors. Note: Only the Credited Portion/Stable Fraction is counted as a reversal.

$$REV_y = \sum \left(Area_{event} \times Density_{char} \times C_{org} \times F_{perm} \times DF_{event} \times \frac{44}{12} \right) \quad \text{Eq. 30}$$

Where

Parameter	Description	Section
REV_y	Quantity of reversed credits. (tCO_2e)	Calculated
$Area_{event}$	Land area or Volume of material affected by the event ha or m^3	Measured
$Density_{char}$	Concentration of biochar in the affected area/volume. (t/unit)	Monitoring Records
C_{org}	Organic Carbon Content of the affected biochar batch. (Fraction)	Section 8
F_{perm}	Permanence Factor previously credited for the batch. (Fraction)	Section 8
DF_{event}	Damage Factor: Fraction of carbon oxidised/lost during the event. (Fraction)	Table 15
$\frac{44}{12}$	Stoichiometric conversion to CO_2. (3.667)	Constant

12.4.2 | **Exemption:** Track 1 (Soil) and Module A2 (Materials) activities settle the reversal-risk deduction by cancellation (Section 11.5 |) and effectively pre-pay for long-term statistical losses. Therefore, individual - event reversal quantification using Equation 30 is not required for these activities, except that for a Track 1 Systemic Breach under Section 11.5 | the reversal is quantified with Equation 30 on the sampled sites and extrapolated to the stratum.

Table 15. Default Damage Factors (DF_{event})

Reversal Event	Context	Damage Factor (DF)	Justification
Wildfire	Surface Applied (<10cm)	0.50 (50%)	High exposure to atmospheric oxidation during severe canopy fire.

Wildfire	Incorporated (>10cm)	0.10 (10%)	Sub-soil effectively insulates pyrogenic carbon from peak heat.
Fuel Diversion	Unauthorized Combustion	1.00 (100%)	Near-total human-caused oxidation.
Cap Breach	Module A3 Vault (Unrepaired > 30 days)	Calculated $\frac{0.95 - F_{perm,local}}{0.95}$	Biochar loses the credited 0.95 anoxic permanence and reverts to the local decay value.
Excavation	Module A3 (Removal from vault)	1.00 (100%)	Complete loss of anoxic protection and assumed combustion/degradation.

12.5 | Addressing Reversals (Compensation)

12.5.1 | **Unavoidable Reversals:** For verified Unavoidable Reversals impacting Track 2/3 monitorable sinks:

a | **Notification:** The Activity Developer shall notify Gold Standard within 30 days of detection.

b | **Cancellation:** Gold Standard shall cancel an equivalent number of credits (REV_y) from the Gold Standard compliance buffer.

c | **Carbon-stock-record update:** The Activity Developer is not financially liable for a verified Unavoidable Reversal, but shall update the activity's monitored carbon-stock record to reflect the reduced quantity of carbon remaining in durable storage, so that subsequent reversal-risk assessment and any further reversal quantification are based on the reduced stock. The crediting baseline remains zero (Section 7); this is a stock adjustment, not a baseline change.

12.5.2 | **Avoidable Reversals:** For verified Avoidable Reversals (e.g., fuel diversion, unauthorised excavation):

12.5.2.1 | **Compensation:** The Activity Developer is liable and shall purchase and retire valid GSVERs equivalent to REV_y from their own registry account within 90 days of detection. Avoidable reversals shall never be compensated from the Gold Standard compliance buffer.

12.5.3 | **Aggregator Liability & Systemic Breach (Track 1):** For distributed activities, the Aggregator assumes strict contractual liability for reversals occurring at individual smallholder farms.

12.5.3.1 | **Systemic Breach Protocol:** If the annual Track 1 Sentinel Site monitoring (Section 16.3) detects verifiable Avoidable Reversals (e.g., fuel diversion) on more than 5.0% of the sampled sites (a share of the sample, not an absolute number of sites), a Systemic Breach of the No-Burn rule is established.

12.5.3.2 | The VVB shall trigger a full audit of the affected geographic stratum. The activity developer shall be liable to compensate the extrapolated REV_y across the entire stratum. Activity crediting shall be suspended, and the

cancellation-route reversal-risk rate ($Risk_{rate}$) for all future issuances shall be doubled (from 10% to 20%) until remedial training is verified by VVB.

13| UNCERTAINTY QUANTIFICATION

13.1 | Approach for Uncertainty Management

13.1.1 |The Activity Developer shall account for uncertainty in the quantification of GHG removals to ensure the environmental integrity of the issued GSVERs. This methodology employs a Tiered Uncertainty Approach determined by the selected Compliance Track to balance rigor with operational feasibility.

13.1.1.1 |**Track 1: Standardised Pre-deducted Uncertainty**: For Track 1 activities, explicit statistical error propagation is not required.

a | **Requirement:** A fixed uncertainty deduction of 5% applies to removals and to activity emissions (Table 10, Table 16), provided the activity adheres to the default factors and eligibility constraints of Track 1.

13.1.1.2 |**Track 2: Standardised Deductions (Fixed)**: For Track 2 activities, uncertainty is addressed through Fixed Deduction Factors applied to specific quantification components. A Track 2 activity may elect, at design certification and per parameter, to apply the calculated approach of Section 13.3 to any parameter it measures to the precision required of Track 3 (platform-scale weighing of biochar and biomass; laboratory organic carbon on batch samples). The fixed deductions continue to apply to the thermal proxy and to composite sampling. The election shall not be reversed within the crediting period.

a | **Requirement:** The activity developer shall apply the fixed factors specified in Table 16.

13.1.1.3 |**Track 3: Statistical Precision (Calculated):** For Track 3 (Industrial) activities, the activity developer shall rigorously calculate the Aggregate Uncertainty of all measured parameters at a 95% Confidence Interval using the Error Propagation logic defined in Section 13.3. If the calculated aggregate uncertainty exceeds the allowable Precision Threshold specified in Equation 34 (1% for removals; 5% for activity emissions), the excess uncertainty shall be deducted from the credited volume.

13.2 | Summary of Uncertainty Requirements

13.2.1 |The Activity Developer shall apply the uncertainty factors (UNC_X) summarized below to the respective equations in Sections 8, 9, and 10.

Table 16. Uncertainty Deduction Matrix

Component	Parameter	Track 1 (Distributed)	Track 2 (Mechanised)	Track 3 (Industrial)	Application

Activity Emissions	UNC_{AE}	0.05 (5%)	0.05 (5%)	Calculated (Threshold 5%)	Addition to AE_y (Eq 9)
Removals	UNC_{AR}	0.05 (5%)	0.05 (5%)	Calculated (Threshold 1%)	Deduction from AR_y (Eq 5)
Leakage	UNC_{LE}	0.00	0.15 (15%)*	0.15 (15%)*	Addition to LE_y (Eq 20)

Note for Leakage: If Track 2/3 uses the Conservative Default Factors (Option A in Section 10), $UNC_{LE} = 0$ =. The 15% adjustment applies only if site-specific modelling (Option B) is used.

13.3 | Calculation of Aggregate Uncertainty (Track 3)

13.3.1 | **Applicability:** Mandatory for Track 3 activities. The Activity Developer shall identify all measured parameters (e.g., Mass, Moisture, Carbon Content) and quantify their uncertainty based on both instrument precision (Systematic Error) and sampling variance (Random Error). *(Note: Purely invoiced utility parameters, such as grid electricity bills or fuel receipts, are deemed to have zero measurement uncertainty)*.

13.3.2 | Published emission factors from authoritative sources (for example, IPCC default factors, national grid emission factors, and standard fuel emission factors) are applied at face value; their intrinsic uncertainty is not separately propagated.

13.3.3 | **Sampling Uncertainty (Random Error):** Where a parameter is determined via sampling (e.g., C_{org} from batch samples), the uncertainty of the mean shall be calculated at the 95% Confidence Interval utilising the Standard Error of the Mean.

$$U_{samp} = \left(\frac{t_{val} \times (SD/\sqrt{n})}{Mean}\right) \times 100 \qquad \text{Eq. 31}$$

Where

Parameter	Description	Source
U_{samp}	Percentage uncertainty of the sample mean. (%)	Calculated
t_{val}	Two-sided t-value for 95% confidence at $n-1$ degrees of freedom.	Statistical Table
SD	Standard Deviation of the sample measurements.	Calculated
n	Number of samples collected during the period. (Integer)	Monitoring Record
$Mean$	Mean value of the samples.	Calculated

13.3.4 | **Combined Uncertainty (Product Rule):** Where the final component value is the product of independent parameters (e.g., $\text{Removals} = \text{Mass} \times \text{Moisture} \times \text{CarbonContent}$), the Combined Uncertainty ($U_{combined}$) is the square root of the sum of squares of the individual precision errors.

$$U_{Combined} = \sqrt{U_1^2 + U_2^2 + U_3^2 + U_n^2} \qquad \text{Eq. 32}$$

Where

Parameter	Description	Source
$U_{Combined}$	Combined relative percentage uncertainty of the product. (%)	Calculated
$U_{1..n}$	Percentage uncertainty of individual parameters (Measurement or Sampling). (%)	Instrument specification or sampling statistics (Section 13.3)

13.3.5 | **Combined Uncertainty (Addition Rule):** Where the final component value is the sum of independent parts (e.g., $Total\ Emissions = Process + Transport$), the Combined Uncertainty is weighted by the magnitude of each contributing part, adding the absolute uncertainties in quadrature.

$$U_{combined} = \frac{\sqrt{(U_1 \times V_1)^2 + (U_2 \times V_2)^2 + \cdots}}{|V_1 + V_2 + \cdots|} \qquad \text{Eq. 33}$$

Where

Parameter	Description	Source
$U_{Combined}$	Combined percentage uncertainty of the sum. (%)	Calculated
$U_{1..n}$	Percentage uncertainty of component n.(%)	Calculated
$V_{1..n}$	Absolute value (tonnes) of component n.(tCO2e)	Calculated

13.3.6 | **Determination of Final Deduction Factors (Track 3)** Once the Aggregate Uncertainty (U_{calc}) is calculated for a component, the final Deduction Factor (UNC_x) is determined by comparing U_{calc} against the allowed Precision Threshold.

$$UNC_x = max\left(0, \frac{U_{Calc} - Threshold}{100}\right) \qquad \text{Eq. 34}$$

Where

Parameter	Description	Source
UNC_x	Final Uncertainty Deduction Factor applied in quantification equations. (Decimal).	Calculated
U_{Calc}	Calculated Aggregate Uncertainty for the component (%)	Calculated

$Threshold$	Allowable error margin per component: Removals (AR): 1.0% (Strict Precision) Activity Emissions (AE): 5.0%	Standard Limit

Example: If a Track 3 project calculates an aggregate uncertainty for Activity Removals of 2.8%, the deduction applied in Equation 5 is: (2.8% - 1.0%) = 1.8% or 0.018.

13.4 | Systematic Error Check (Calibration):

13.4.1 |**Requirement:** To prevent systematic data drift, all mass measurement scales (Hub hanging scales, platform weighbridges), moisture meters, and Track 3 CEMS equipment shall be calibrated according to the manufacturer's specifications or annually, whichever is more frequent, against certified standard weights or reference gases. Utility-owned grid electricity meters governed by national standards are explicitly exempt from activity-level calibration requirements. Track 1 low-cost spring scales shall be calibrated monthly against a known "Standard Weight" at the Aggregator Hub.

13.4.2 |**Consequence:** If a calibration certificate is missing, expired or invalid during the verification audit, the specific Uncertainty Deduction linked to that instrument's data pool (e.g., UNC_{AR} for missing biochar scale calibrations, or UNC_{AE} for missing CEMS calibrations) is automatically overridden and raised to a punitive 0.20 (20%) for the undocumented monitoring period, superseding Equation 34 and the Track 1/Track 2 defaults.

13.4.3 |**Bias Correction:** If an instrument (e.g., a platform scale) is found to be over-reading (reading higher mass than actual) during the VVB audit or routine calibration check, the entire recorded volume for the affected parameter shall be uniformly discounted by the verified percentage error. This retrospective discount shall be applied strictly to all data logged since the exact date of the last successful calibration event.

14| MEETING METHODOLOGICAL PRINCIPLES

14.1 | Encouraging Ambition over Time

14.1.1 |The crediting baseline is zero and net removals are reduced by the downward adjustment factor of Section 11.6, aligning issuance with the Host Country's net-zero trajectory; the adjusted quantity is reported each period as the Host Country's contribution.

14.1.2 |Fossil fuels may not sustain the pyrolysis reaction (Section 3.2), and lock-in risk is assessed under Section 6.3.

14.2 | Equitable Sharing of Mitigation Benefits

14.2.1 |**Benefit Sharing Plan Mechanism:** For any activity utilising an aggregation model across ANY Compliance Track (Track 1, Track 2, or Track 3) where

biomass is sourced from distributed third-party smallholder farmers, the Activity Developer (or Aggregator) shall establish and document a transparent Benefit Sharing Plan.

14.2.1.1 | **Requirement:** The plan shall specify how carbon value is returned to the frontline biomass suppliers (e.g., via direct cash payments, heavily subsidised/free return of the biochar product for soil improvement, or funded community infrastructure).

14.2.1.2 | **Verification:** The implementation of this plan shall be audited during verification to ensure that smallholders are not excluded from the financial benefits of the assets they generated.

14.3 | Avoidance of Double Counting

14.3.1 | The activity developer shall implement the following measures to prevent double counting, double issuance, or double claiming, consistent with Requirement 5.4.1(f)(iii) of the Methodology Standard: Requirements for Methodology Development, and the GS4GG GHG Emissions Reduction & Sequestration Product Requirements

14.3.1.1 | **End-Use Exclusivity (Materials):** Where biochar is used in Module A2 (Engineered Materials), the developer shall obtain an "Assignment of Rights" from the downstream manufacturer (e.g., concrete batch plant). This ensures the manufacturer does not separately claim the sequestration benefit (e.g., producing "carbon-neutral" cement for an Environmental Product Declaration) without formally retiring the associated credits.

14.3.1.2 | **Scope 3 "Insetting" Mitigation:** To prevent double claiming between the Voluntary Carbon Market and Corporate GHG Inventories, any specific volume of biochar co-financed by a supply chain partner (e.g., an off-taker paying a premium for low-carbon crops to claim the removals in their Scope 3 inventory, or a carbon-negative cement buyer) is strictly ineligible for GSVER issuance. Issuance may only proceed if a formal "Carbon Rights Waiver" is executed by the corporate partner transferring the exclusive atmospheric claim to the Activity Developer.

14.3.1.3 | **Soil Overlap:** Where the biochar is incorporated into soil (Module A1), the Activity Developer shall confirm that the target fields are not concurrently registered under a separate SOC crediting activity at any point of in time during the crediting period under this methodology. Where the fields are part of another carbon activity, the biochar application is ineligible to claim removals under this methodology to prevent duplicate crediting on the same land polygon.

14.3.1.4 | **Overlap with domestic mitigation schemes:** The activity shall not be covered by a mandatory domestic mitigation scheme (e.g. an emissions trading system). Where the removals are covered by a mandatory domestic mitigation scheme, the affected quantity shall not be eligible for GSVER issuance unless the Activity Developer demonstrates, through verifiable evidence, that the same removals will not also be counted towards a target, obligation, or other mandatory mitigation outcome under that scheme.

GSVERs shall not be issued for the affected quantity until this requirement is met.

14.4 | Aligning with NDC and LT-LEDS

14.4.1 | The activity shall demonstrate alignment with the Host Country's Nationally Determined Contribution (NDC) and Long-Term Low-Emission Development Strategy (LT-LEDS).

14.4.1.1 | **Broad Alignment:** The activity developer is not required to prove that "Biochar" is explicitly named in the NDC text. Alignment is successfully demonstrated if the activity broadly supports the Host Country's stated goals for the AFOLU or Waste sectors (e.g., "improving agricultural soil health," "reducing municipal waste," or "halting deforestation").

14.4.1.2 | **Conflict Screening:** The activity developer shall confirm that the diversion of biomass does not conflict with national strategies for Energy Security: (e.g., diverting biomass mandated for baseload grid power) or Food Security.

14.5 | Encouraging Broad Participation

14.5.1 | The three compliance tracks admit artisanal, mechanised and industrial producers under monitoring requirements proportionate to their scale, so that smallholder networks in least-developed countries and industrial facilities are both eligible without lowering the standard applied to either.

14.6 | Including Data Sources, Accounting for Uncertainty, and Monitoring

14.6.1 | The methodology prioritises the use of observed, accurate, and verifiable data while accommodating data scarcity in specific contexts through conservative defaults.

14.6.2 | Track 3 measures all parameters directly; Track 1 applies the standardised defaults of Annex 5, set at conservative bounds and corroborated by periodic third-party characterisation; Track 2 measures mass, unless it selects the Annex 5 default, carbon content and applies fixed uncertainty deductions to its simplified methods. Uncertainty is treated under Section 13.

14.7 | Taking into Account Policies, Measures, and Relevant Circumstances

14.7.1 | The Baseline Scenario and Additionality Demonstration explicitly account for national and sub-national policies.

14.7.1.1 | **Regulatory Surplus:** The activity shall demonstrate that the production and durable application of biochar is not mandated by law (section 6.2). Because this is a pure-CDR methodology that credits only the durable removal — not avoided emissions from the counterfactual fate of the biomass — laws governing the baseline fate of residues (for example, bans

on open burning) are not relevant legal requirements for regulatory surplus and do not affect additionality; the activity's compliance with any such laws is nonetheless confirmed.

15| MONITORING METHODOLOGY

15.1 | General Requirements

15.1.1 |The Activity Developer shall establish and maintain a Monitoring, Reporting, and Verification (MRV) system that ensures the continuous, accurate, and transparent quantification of GHG removals and operational emissions. The monitoring plan shall be defined in the PDD and executed according to the selected Compliance Track.

15.1.2 |**Roles and Responsibilities:** The MRV system shall clearly define roles across the entire cradle-to-grave lifecycle:

15.1.2.1 |**Track 1 (Distributed):** The Aggregator acts as the central data manager. The Aggregator is responsible for maintaining the Digital Registry of all production units, including commissioning dates, capacities, operational status and replacement or decommissioning records, collecting calibration logs, conducting composite sampling, and aggregating data for the Monitoring Report. Individual smallholders operate kilns and log data via the Aggregator's digital platform.

15.1.2.2 |**Track 2 (Mechanised) AND Track 3 (Industrial):** The Facility Operator/Plant Manager is responsible for onsite data logging (e.g., weighbridge, thermocouples, SCADA, CEMS) and Composite Sampling.

15.1.2.3 |**Logistics & Application Managers (All Tracks):** Designated personnel responsible for tracking the Chain of Custody during transport and formally documenting the final Proof of Application ($Proof_{App}$) at the downstream sink (e.g., field applicators logging geo-tagged planting pits, or site managers retaining B2B concrete batch invoices).

15.1.3 |**Data Management and Archiving**

15.1.3.1 |**Digital MRV:** For all Tracks, the use of a secure Digital Monitoring System (DMS) or SCADA data historian is mandatory. For Track 1 and 2, this shall include time-stamped and geo-tagged delivery receipts. Paper logs shall be digitised within 30 days.

15.1.3.2 |**Retention:** All data, including weighbridge tickets, lab reports, and spatial application polygons, shall be archived in accordance with the record-retention requirements of the GS4GG Principles and Requirements and the Activity Requirements.

15.1.4 |**Calibration**

15.1.4.1 |**Requirement:** All measurement equipment used for crediting (scales, moisture meters, thermocouples, CEMS) shall be calibrated according to manufacturer's specifications or annually, whichever is more frequent (Section 13.4). Due to rapid carburisation and thermal drift in high-temperature corrosive environments, critical thermocouples utilised for

Track 2 Thermal Proxies or Track 3 reactors shall be inspected, recalibrated, or replaced at least bi-annually (every 6 months), or the facility shall utilise dual-redundant sensor arrays.

15.1.4.2 | **Track 1 Exception:** Low-cost Spring scales shall be calibrated monthly against a "Standard Weight" at the Aggregator Hub.

15.1.4.3 | **Utility Exemption:** Utility-owned grid electricity meters, governed by national utility standards and sealed by the provider, are explicitly exempt from activity-level calibration requirements.

15.2 | Data and parameters not monitored

15.2.1 | The following parameters are determined ex-ante and remain fixed for the duration of the crediting period, unless otherwise noted.

Parameter ID	**PARC 1**
Data/parameter:	GWP (CH_4); GWP (N_2O)
Description	Global Warming Potential of Methane and Nitrous Oxide.
Data unit:	
Purpose of data:	☒ Activity emissions
Value(s) applied:	CH4: 28; N_2O: 265 (100-year, IPCC Fifth Assessment Report).
Source of data:	☐ Measured ☒ Other source IPCC (2014), Fifth Assessment Report, Working Group I, Table 8.A.1 (100-year, without climate-carbon feedback).
Choice of data or measurement methods and procedures:	
Treatment of uncertainty	N/A
Comments:	Used to convert non-CO_2 gases into carbon dioxide equivalents. Applicable Track - All Tracks Applicable Module - All Modules

Parameter ID	**PARC 2**
Data/parameter:	$DAF_{Netzero,y}$
Description	Downward Adjustment Factor applied to align the activity with the Host Country's Net Zero trajectory.
Data unit:	Decimal Fraction
Purpose of data:	☒ Downward adjustment (Section 11.6)
Value(s) applied:	The value published for the applicable period in MT400-05.
Source of data:	☐ Measured ☒ Other source

	GS4GG Tool: Downward Adjustment Factor Determination (MT400-05). Mandatory requirement for Paris Agreement Alignment (PAA).
Choice of data or measurement methods and procedures:	
Treatment of uncertainty	N/A
Comments:	Applicable Track - All Tracks Applicable Module - All Modules

Parameter ID	**PARC 3**
Data/parameter:	$Y_{default}$
Description	Conservative feedstock -specific Biochar Yield Factor used to calculate dry biomass input from weighed biochar output.
Data unit:	Ratio ($t_{char,dry}$/ $t_{bio,dry}$)
Purpose of data:	☒ Leakage emissions
Value(s) applied:	Woody biomass: 0.15; Crop residues, nutshells and husks: 0.15
Source of data:	☐ Measured ☒ Other source Annex 5 of this methodology.
Choice of data or measurement methods and procedures:	10th percentile of field-measured flame-curtain yields (Annex 5, Table 20). Not applicable to Module F1 field residue, which is weighed (Section 8.3).
Treatment of uncertainty	N/A
Comments:	Applicable Track - Track 1 (Distributed) Only Applicable Module - Modules F2,F3 & F4 Prohibited for Track 2 and Track 3.

Parameter ID	**PARC 4**
Data/parameter:	$EF_{Ch4,tech}$; $EF_{Ch4,penalty}$
Description	Technology-specific factor quantifying methane slip (uncombusted pyrolysis gases) and the Track 2 Proxy Excursion Penalty.
Data unit:	tCH_4/t_{char}
Purpose of data:	☒ Activity emissions
Value(s) applied:	Flame-curtain kilns: 0.0055 (feedstock ≤ 15% moisture); 0.020 (>15% to 24%); above 24% not creditable

	TLUD gasifiers: no default; activity-specific factor under Section 9.4, Option B Proxy Excursion Penalty (Track 2): 0.15
Source of data:	☐ Measured ☒ Other source Annex 5 of this methodology.
Choice of data or measurement methods and procedures:	At or above the highest value measured in the moisture class (Annex 5, Table 22).
Treatment of uncertainty	N/A
Comments:	Unvented earth mounds are Prohibited. Applicable Track - Track 1 ($EF_{CH4,tech}$); Track 2 ($EF_{CH4,penalty}$) Applicable Module - All Modules

Parameter ID	**PARC 5**
Data/parameter:	$EF_{embodied,default}$
Description	Standardised deduction for embodied emissions of production infrastructure (steel, concrete).
Data unit:	tCO_2/t_{char}
Purpose of data:	☒ Leakage emissions (embodied, Section 10.4)
Value(s) applied:	0.02 (Track 1) | 0.05 (Track 2)
Source of data:	☐ Measured ☒ Other source **Methodology Default**
Choice of data or measurement methods and procedures:	Simplifies MRV by avoiding full Life Cycle Assessment (LCA).
Treatment of uncertainty	N/A
Comments:	Applicable Track - Track 1 & Track 2 Applicable Module - All Modules

Parameter ID	**PARC 6**
Data/parameter:	$MAST$
Description	Mean Annual Soil Temperature (0–30 cm depth) at the application site.
Data unit:	Degrees Celsius (°C)
Purpose of data:	☒ Activity removals

Value(s) applied:	Activity specific
Source of data:	☐ Measured ☒ Other source Recognised global gridded soil-temperature dataset (e.g., NASA POWER, ISRIC SoilGrids, ERA5-Land), as required by Section 8.5.
Choice of data or measurement methods and procedures:	Site-specific value (Centroid of Application Boundary). Required for the Woolf et al. (2021) decay model (F_{perm}).
Treatment of uncertainty	N/A
Comments:	Applicable Track - All Tracks (Track 1 may apply the 25^{0}C default) Applicable Module - A1 (Soil), (Note: Module A3 only utilizes this parameter if an engineered cap breach occurs and reverts to the standard soil decay model) Track 1 may apply the conservative default of 25^{0}C without site measurement (Section 8.5).

15.2.2 | **PARC 7: $C_{org,default}$ (Default Organic Carbon):** Values of 0.55 (woody biomass; nutshells, stones and pits), 0.45 (herbaceous and other crop residues, bagasse), 0.35 (rice husk and high-silica husks), 0.25 (animal manure; biosolids — informative only: Module F6 is restricted to Track 3, which measures the organic carbon). Sourced from Annex 5, Table 21. Default pathway (Track 1; Track 2 where elected).

15.2.3 | **PARC 8: MC_{deduct} (Default Moisture Deduction):** Values of 0.15 (Air -or snuff quenched) and water quenched biochar shall be metered and has no default. Sourced from Annex 5. Restricted to Track 1.

15.2.4 | **PARC 9: L_{app} (Application Loss Factor):** Values of 0.02 (Precision/Manual), 0.05 (Mechanised Surface), and 0.01 (Encapsulation/Burial). Zero where the biochar is weighed at placement or at plant or vault intake under chain of custody. Sourced from Section 8.6 (Table 9). Applicable to all Tracks based on the End-Use Module.

15.2.5 | **PARC 10: $EF_{replace,i}$ (Default Replacement Factors):** Values of 1.75 (boiler or kiln fuel, woody biomass; coal or non-renewable wood replaced), 1.30 (boiler or kiln fuel, herbaceous residue), 0.27 and 0.20 (household cooking fuel, woody and herbaceous, where LPG is the demonstrated replacement); fodder, bedding and mulch by site-specific calculation (Option B). Sourced from Section 10.5 (Table 12). Used to calculate Market Leakage.

15.2.6 | **PARC 11: Reversal Risk Rate:** 10% for Track 1 Module A1 and 3% for Module A2, cancelled at issuance; the Annex 7 assessment (base risk 7.5%) for Tracks 2 and 3 Module A1 and 2.5% for Module A3, deposited in the buffer. No rate shall be lower than 2.5%. See Sections 11.5 and 12.2.

15.2.7 | **PARC 12: Permanence Factor:** 0.95 for Module A2 (Engineered Materials) and Module A3 (Earth Vaults), unless the vault-breach provisions of Section

12.4 apply. The selected Permanence Factor is separate from the buffer or risk deduction.

15.3 | Data and parameters monitored

15.3.1 |The following parameters shall be monitored during the crediting period.

15.3.2 |Operational status monitoring: For each production unit, the Activity Developer shall record the commissioning date, operational status, periods of seasonal or intermittent operation, capacity, production during the monitoring period, and any permanent decommissioning or replacement. The record shall be updated at commissioning, replacement or decommissioning and at least annually. Credits shall be issued only for production during documented operation or after a verified replacement has been added to the activity boundary or registry.

Parameter ID	**PARC 13**	
Data/parameter:	$Q_{biomass,i,y}$	
Description:	Mass of biomass feedstock type i processed during the monitoring period.	
Data unit:	Tonnes (t_{wet} or t_{dry})	
Purpose of data:	☒ Leakage emissions	
Measurement and updating frequency	a. Track 1: Aggregator logs. b. Track 2: Facility Weighbridge. c. Track 3: Automated Weigh feeder. Per Batch (Track 1/2) or Continuous (Track 3).	
Measurement methods and procedures:	a. Track 1: calculated by yield back-calculation ($Q_{biochar,dry}/Y_{default}$) or measured with hanging scales. b. Track 2/3: Direct weighing of inputs. Records shall include timestamp and feedstock type.	
Entity/person responsible for the measurement:		
Measuring instrument(s):	Type of instrument	N/A
	Accuracy class	N/A
	Calibration requirements	N/A
	Location	N/A
QA/QC procedures:	Scales are calibrated according to the manufacturer's specification or annually, whichever is more frequent (Section 13.4).	

	$Q_{char}Y_{default}$Mass balance check: where the recorded yield (biochar dry mass divided by feedstock dry mass) exceeds the Annex 5, Table 20 maximum for the declared feedstock class, the batch is quarantined under Section 8.3.
Treatment of uncertainty	-
Comments:	Calculation of Leakage (Section 10) and the mass balance check (Section 8.3). Applicable Track – All tracks Applicable Module - All modules

Parameter ID	**PARC 14**	
Data/parameter:	$MC_{biomass}$	
Description:	Moisture content of the biomass feedstock input.	
Data unit:	Decimal Fraction	
Purpose of data:	☒ Activity emissions (moisture class, Section 9.4); Leakage emissions	
Measurement and updating frequency	Per Batch (Track 1/2) or Daily Composite (Track 3).	
Measurement methods and procedures:	Moisture Analyser / Lab Report. a. Track 1: Calibrated handheld meter at charging, every batch (Section 9.4) b. Track 2: Gravimetric analysis (Oven 105°C). c. Track 3: Inline NIR sensors or Lab Analysis.	
Entity/person responsible for the measurement:		
Measuring instrument(s):	Type of instrument	N/A
	Accuracy class	N/A
	Calibration requirements	N/A
	Location	N/A
QA/QC procedures:	Handheld meters calibrated against oven-dry method quarterly.	
Treatment of uncertainty		

Comments:	Conversion of wet input weight to dry weight. Applicable Track – All tracks Applicable Module - All modules

Parameter ID	**PARC 15**	
Data/parameter:	$EC_{pre-proc,y}$ $FC_{proc,y}$	
Description:	Electricity and Fossil Fuel consumed for processing, startup, and auxiliary equipment.	
Data unit:	MWh (electricity); Liters (or kg) (fuel)	
Purpose of data:	☒ Activity emissions	
Measurement and updating frequency	Monthly.	
Measurement methods and procedures:	Utility Meters / Fuel Purchase Invoices. Recording of meter readings at the start/end of the period.	
Entity/person responsible for the measurement:		
Measuring instrument(s):	Type of instrument	N/A
	Accuracy class	N/A
	Calibration requirements	N/A
	Location	N/A
QA/QC procedures:	Consistency check against equipment nameplate rating. Utility-owned grid meters are exempt from activity-level calibration requirements.	
Treatment of uncertainty		
Comments:	Calculation of Activity Emissions. Applicable Track – All tracks Applicable Module - All modules	

Parameter ID	**PARC 16**
Data/parameter:	$Q_{biochar,i,y}$

Description:	Mass of final biochar output produced and distributed to eligible sinks, net of verified mineral additive mass.	
Data unit:	Tonnes (t_{wet})	
Purpose of data:	☒ Activity removals (Equation 5); activity emissions (Equation 15); leakage (Equation 21)	
Measurement and updating frequency	Every Batch (Track 1/2) or Continuous (Track 3).	
Measurement methods and procedures:	Direct weighing of the final product prior to storage or transport. Weight tickets shall correspond to batch IDs. Mineral additives shall be quantified separately using source weigh tickets, formulation records, or representative post-production analysis, and their verified mass shall be subtracted from gross biochar output to determine the net creditable mass. Track 1: Aggregator Log (Bag Count × Std Weight via calibrated hanging scale). Track 2: Platform Scales (Bulk Bags). Track 3: Product Weighbridge.	
Entity/person responsible for the measurement:		
Measuring instrument(s):	Type of instrument	N/A
	Accuracy class	N/A
	Calibration requirements	N/A
	Location	N/A
QA/QC procedures:	Scales calibrated per manufacturer specifications or annually. Cross-check against batch records. Reconcile mineral additive mass to formulation records or representative post-production analyses and verify that net creditable mass equals gross biochar output less verified mineral additive mass.	
Treatment of uncertainty		
Comments:	Applicable Track – All tracks Applicable Module - All modules	

Parameter ID	**PARC 17**
Data/parameter:	$MC_{biochar}$

Description:	Moisture content of the biochar output.	
Data unit:	Decimal Fraction	
Purpose of data:	☒ Activity removals	
Measurement and updating frequency	Per Lot/Batch. Track 1: Meter calibrated to charcoal setting OR the conservative defaults defined in Annex 5 (15% for Air or snuff quench; water-quenched biochar shall be metered). Moisture sampling shall occur simultaneously with the physical weighing of biochar to ensure mass-balance integrity Track 2/3: Gravimetric analysis - Dry sample at 105°C to constant weight.	
Measurement methods and procedures:	Direct weighing of final product prior to storage/transport. Weight tickets shall correspond to Batch IDs. Track 1: Meter/Default. Track 2: Oven. Track 3: Lab/Sensor.	
Entity/person responsible for the measurement:		
Measuring instrument(s):	Type of instrument	N/A
	Accuracy class	N/A
	Calibration requirements	N/A
	Location	N/A
QA/QC procedures:	Duplicate samples tested for 5% of batches (Track 2/3).	
Treatment of uncertainty		
Comments:	Conversion of wet output weight to dry weight. Applicable Track – All tracks Applicable Module - All modules	

Parameter ID	**PARC 18**
Data/parameter:	C_{org} , $H{:}C_{org}$
Description:	Organic Carbon Content (C_{org}) and Hydrogen-to-Organic Carbon Ratio ($H{:}C_{org}$) and, for Track 2 and Track 3, the Oxygen-to-

	Organic Carbon Ratio (O:Corg, ISO 16948 or DIN 51733, Section 3.2 |).	
Data unit:	Decimal Fraction, Molar Ratio	
Purpose of data:	☒ Activity removals	
Measurement and updating frequency		
Measurement methods and procedures:	Accredited Laboratory Analysis (ISO 17025). Elemental Analysis (CHNS). Track 1/2: Composite Sampling permitted Track 3: Batch Sampling required.	
Entity/person responsible for the measurement:		
Measuring instrument(s):	Type of instrument	N/A
	Accuracy class	N/A
	Calibration requirements	N/A
	Location	N/A
QA/QC procedures:	Track 1 (where measured): a batch with H:Corg above 0.4 is ineligible for crediting. Track 2 and Track 3: H:Corg of 0.5 or below is creditable under Method 1; above 0.5 and up to 0.7 only under Method 2 (PARC 22); above 0.7 is ineligible.	
Treatment of uncertainty		
Comments:	Calculation of Sequestration Potential and Permanence Factor. Applicable Track – All tracks Applicable Module - All modules	

Parameter ID	**PARC 19**
Data/parameter:	T_{SCC} , $T_{process}$
Description:	Operating temperature of the Secondary Combustion Chamber (SCC) or Carbonisation Zone.
Data unit:	Degrees Celsius (°C)
Purpose of data:	☒ Activity emissions (thermal proxy, Section 9.4); eligibility (450 °C minimum, Section 3.2)

Measurement and updating frequency	Continuous.	
Measurement methods and procedures:	Thermocouple / Data Logger / SCADA. Track 2: Type K or Type N thermocouple (accuracy class 1) at the SCC outlet, logged at intervals of 60 seconds or less (Annex 4). Track 3: Continuous process monitoring.	
Entity/person responsible for the measurement:		
Measuring instrument(s):	Type of instrument	N/A
	Accuracy class	N/A
	Calibration requirements	N/A
	Location	N/A
QA/QC procedures:	Track 2 Safeguard: If T_{SCC} < 850^{0}C or the residence time is below 2s, the thermal proxy fails. The specific volume of biochar produced strictly during the undocumented/excursion period shall be subjected to the Excursion Penalty Factor as per Annex 5.	
Treatment of uncertainty		
Comments:	Verification of Methane Destruction (Thermal Proxy). Applicable Track – Track 2 & Track 3 (Mandatory) Applicable Module - All modules	

Parameter ID	**PARC 20**
Data/parameter:	$Conc_{CH4}$
Description:	Concentration of Methane in the facility flue gas.
Data unit:	mg/m^3
Purpose of data:	☒ Activity emissions
Measurement and updating frequency	Continuous.

Measurement methods and procedures:	Continuous Emissions Monitoring System (CEMS). NDIR or FID Analyser installed in the stack.	
Entity/person responsible for the measurement:		
Measuring instrument(s):	Type of instrument	N/A
	Accuracy class	N/A
	Calibration requirements	N/A
	Location	N/A
QA/QC procedures:	Daily automated zero/span checks; Annual RATA.	
Treatment of uncertainty		
Comments:	Precise quantification of Activity Emissions. Applicable Track – Track 3 (Industrial) Only Applicable Module - All modules	

Parameter ID	**PARC 21**
Data/parameter:	$Proof_{App}$
Description:	Evidence confirming the biochar was applied to an eligible sink.
Data unit:	Document / Record
Purpose of data:	☒ Activity removals
Measurement and updating frequency	Every Credited Batch.
Measurement methods and procedures:	Digital Monitoring System / Sales Records. A1 (Track 1): Geo-tagged photos / Farmer Logbooks. A1/A2/A3 (Track 2/3): Signed Weighbridge Tickets / Sales Ledgers. A3: As-built Survey.
Entity/person responsible for the measurement:	

Measuring instrument(s):	Type of instrument	N/A
	Accuracy class	N/A
	Calibration requirements	N/A
	Location	N/A
QA/QC procedures:	VVB audits a random sample of end-locations during verification.	
Treatment of uncertainty		
Comments:	Eligibility condition for Removals (Chain of Custody). Applicable Track – All Tracks Applicable Module - All modules	

Parameter ID	**PARC 22**	
Data/parameter:	$\%Inertinite\ and\ R_0$	
Description:	Fraction of data points in the biochar samples that have random reflectance (R_0) of 2% or more	
Data unit:	Percentage (%).	
Purpose of data:	☒ Activity removals; the sole basis for 1,000-year high-durability (premium) claims and for crediting biochar with a molar H:C_{org} between 0.5 and 0.7 (Method 2).	
Measurement and updating frequency	Track 2 or Track 3 (Where Method 2 is selected): required during baseline calibration, when switching feedstock, or crossing continuous lot thresholds.	
Measurement methods and procedures:	Optical white light microscopy (e.g., ISO 7404-5:2025 or ASTM D2798) conducted by an independent accredited laboratory.	
Entity/person responsible for the measurement:	Independent Laboratory that is accredited by relevant accreditation board.	
Measuring instrument(s):	Type of instrument	N/A
	Accuracy class	N/A
	Calibration requirements	N/A

	Location	N/A
QA/QC procedures:	A minimum of 500 point-counts shall be made per sample. The creditable inertinite fraction is the mean point-counted fraction less one standard deviation (a conservative lower bound), per Sanei et al. (2024).	
Treatment of uncertainty		
Comments:	Determination of high-durability (1,000-year) permanence and eligibility of biochar with H:C_{org} between 0.5 and 0.7 (Method 2, Section 8.5 |). Random reflectance R_0 ≥ 2%. Sourced from Annex 4.	

15.4 | QA/QC and Data Management

15.4.1 | Composite Sampling Protocol (Track 1 and Track 2): To ensure cost-effectiveness for LDCs, Biochar Hubs are permitted to use Composite Sampling for laboratory analysis ($Corg$ and $H{:}Corg$):

15.4.1.1 | **Protocol:** A minimum of six physical sub-samples is taken from every batch delivered to the Hub (Section 8.4).

15.4.1.2 | **Composite Sampling Protocol (Track 1 & 2):** Subsamples thoroughly mixed to create a single Master Sample.

a | **Track 1:** The Master Sample shall represent a maximum of 50 metric tonnes of production, OR 1 calendar month (whichever occurs first) to prevent staleness.

b | **Track 2:** The Master Sample shall represent a maximum of 100 metric tonnes, OR 1 calendar month (whichever occurs first).

15.4.1.3 | **Homogeneity Condition:** Only biochar within a feedstock class of Annex 5, Table 21 may be mixed. Biochar of different classes requires separate composite samples.

15.4.2 | **"Missing Data" (Conservative Replacement):** In the event of a failure of monitoring equipment (e.g., CEMS downtime, broken weighbridge, corrupt data logs) exceeding 24 hours, the Activity Developer shall not exclude the period nor use average values. The Developer shall apply the Most Conservative Value recorded during the previous 12 months to the missing period:

a | **For Emissions (e.g., Stack Methane):** Apply the Maximum recorded concentration.

b | **For Removals (e.g., Biochar Mass):** The activity developer shall mathematically back-calculate the volume strictly utilising the recorded biomass input multiplied by the lowest theoretical default yield factor for that feedstock (e.g., 15%), ensuring a highly conservative estimate.

15.4.3 | **Pre-Monitoring End-Use QA/QC:** To strictly mitigate reversal risks, the VVB shall audit the End-Use application evidence prior to verification:

a | **Module A1 (Soil):** Verify that geo-tagged photographic evidence ($Proof_{App}$) demonstrates physical incorporation (e.g., tilling, planting pits) rather than biochar merely sitting in unapplied bags. Check that the tonnage applied to any field in a single application does not exceed the cap in Section 3.4.

b | **Module A2 (Materials):** Audit the B2B sales contracts to verify the inclusion of clauses expressly prohibiting the use of the biochar in combustible polymers and assigning the CDR rights solely to the Activity Developer.

c | **Module A3 (subterranean Dedicated Earth Vaults):** Verify the receipt of the formal engineering As-Built survey confirming the impermeable cap installation prior to crediting.

15.5 | Correlated Proxy Protocol (Ash Proxy)

15.5.1 |To reduce laboratory costs for Track 1, the aggregator may establish a site-specific Correlation Curve between Ash Content and Organic Carbon (C_{org}), as follows:

a | **Calibration:** Analyse 10 samples at an ISO 17025 lab to establish the regression ($R^2 \geq 0.90$).

b | **Routine monitoring:** Measure Ash Content onsite for every batch using a muffle furnace (ASTM D1762). Apply the curve to derive C_{org}.

c | **Audit:** Send every 50th sample to the ISO lab to re-validate the curve. Proxy-derived organic carbon shall be applied at the one-sided lower 95% confidence bound of the regression on the conditional mean, not at the fitted value.

16| MONITORING REQUIREMENTS FOR ACTIVITIES WITH REVERSAL RISKS

16.1 | General Requirements.

16.1.1 |The objective of this monitoring component is to detect and quantify **Event-Based Reversals**—defined as the unintentional or intentional release of sequestered carbon due to disturbance events (e.g., severe wildfire, topsoil stripping, fuel diversion, demolition, vault cap failure)—that occur within the Activity Boundary.

16.1.1.1 |**Monitoring Period:** Reversal monitoring shall be conducted during active crediting period - annually, concurrent with the standard verification cycle.

16.1.1.2 |**Post-Crediting Exemption:** Active physical monitoring naturally ceases at the end of the final Crediting Period (maximum 15 years). After the final crediting period the 200-year claim is secured ex ante, for each module, as follows: for Module A1, by the Permanence Factor, which credits only the carbon expected to remain after 200 years, and by the buffer contribution or fixed cancellation held against reversal events; for Module A2, by the

same two instruments and by the encapsulation evidence retained under Section 16.3 |; for Module A3, by the same two instruments and by the legal covenant, which runs for the full credited duration (Section 12.3 |). Upon activity closure, no further physical monitoring reports are required, provided all Legal Safeguards (e.g., Vault Deed Restrictions) have been verified as active. For the avoidance of doubt, the cessation of required monitoring *before* the end of the final crediting period — where monitoring is feasible (Track 2 and Track 3 monitorable sinks) and is discontinued without justification — shall be treated as an Avoidable Reversal. The post-crediting exemption above applies only to the natural cessation of monitoring at the end of the final crediting period, where the residual permanence is secured by the Gold Standard pool, the ex-ante deductions, and the active Legal Safeguards.

16.2 | Responsibility

16.2.1 |**Track 1**: The Aggregator assumes strict liability for monitoring the distributed network of application sites and conducting Sentinel Site inspections.

16.2.2 |**Track 2 & 3**: The Activity Developer is responsible for monitoring the defined Application Boundary via Remote Sensing, ground truthing, or downstream engineering inspection.

16.3 | Monitoring Methods by End-Use Module

16.3.1 |The Activity Developer shall implement the monitoring approach corresponding to the End-Use Module and Compliance Track.

16.3.2 |**Module A1: Soil Application (Track 1 - Distributed):** Sentinel Site monitoring functions as a systemic breach check of Aggregator compliance with the "No-Burn" rule; it does not calculate individual reversal tonnages. This sample-based Sentinel audit is distinct from, and additional to, the census-level geo-tagged proof of incorporation required for every credited batch (Section 12; PARC 21).

16.3.2.1 |**Sentinel Site Inspections:** The Aggregator shall inspect a representative sample of Sentinel Sites annually. The sample size shall be determined in strict accordance with the *Article 6.4 methodological tool: Sampling and surveys (A6.4-AMT-010)* to achieve a minimum 90/10 confidence/precision level, rounded up.

16.3.2.2 |**Visual Assessment:** The field monitor shall visually assess the field for:

a | **Fuel Diversion:** Evidence of biochar being excavated for use as charcoal (e.g., pits, stockpiles near kitchens).

b | **Soil Displacement/Conversion:** Evidence of topsoil stripping (e.g., surface mining) or land-use conversion (e.g., paving over the field). *(*Note*: Standard agricultural deep-ploughing or tilling is an agronomic norm that protects pyrogenic carbon and does NOT constitute a reversal).*

c | **Fire:** Evidence of recent scorching or burning of crop residues on the treated field.

16.3.2.3 | **Trigger:** If >5% of sampled Sentinel Sites (rounded up to the next whole site) show verified evidence of Avoidable Reversals (e.g., intentional fuel diversion), it indicates systemic breach. This triggers the Aggregator Liability Clause (Section 12.5 |), resulting in a full audit of the affected geographic stratum, potential activity suspension, and doubling of the cancellation-route reversal-risk rate (Section 12.5 |) for future issuances.

16.3.3 | **Module A1: Soil Application (Track 2 and 3 - Mechanised):** For large-scale contiguous application areas (or Track 2 activities with defined commercial partners), monitoring relies on remote sensing.

a | **Remote Sensing Analysis:** The Activity Developer shall analyse satellite imagery (e.g., Sentinel-2, Landsat, or VIIRS Active Fire data) covering the Application Boundary annually to identify "Burn Scars" overlapping with registered land parcels or Conversion of agricultural/forestry land to settlements or infrastructure (impervious surfaces).

b | **Ground Truthing:** If remote sensing detects a disturbance event (e.g., High Severity Fire) overlapping with >5% of the total application area, a ground survey is mandatory to quantify the depth of biochar loss (e.g., distinguishing surface ash from intact sub-soil carbon) and applying the relevant Damage Factor (Table 15). Note: For Track 2 activities involving distributed smallholder application, the Track 1 Sentinel Site protocol shall be used.

16.3.4 | **Module A2: Engineered Materials (Tracks 2 and 3):** Biochar encapsulated in concrete or asphalt is not monitored for the physical existence of the infrastructure after issuance.

a | **Reversal-risk deduction:** Module A2 activities rely entirely on the 3% reversal risk deduction, cancelled at issuance (Section 11.5 | and 12.2 |, Table 14).

b | **Monitoring Status:** Deemed Compliance for physical infrastructure lifespan tracking after issuance. The Activity Developer is not required to maintain a long-term asset registry or track individual infrastructure lifespans ex post, provided the executed B2B Non-Combustion Encapsulation Contracts, the encapsulation evidence, and the relevant permanence and risk deductions are retained and verified at issuance. Evidence of the placement layer (for asphalt) and of the mix design (for concrete) shall be retained for every credited batch and verified at issuance.

16.3.5 | **Module A3: Dedicated Earth Vaults (Track 2 & 3)**: Monitoring focuses on the integrity of the engineering controls and legal status.

a | **Cap Integrity** Inspection**:** Annual visual inspection of the site surface for signs of erosion, subsidence, or unauthorised excavation, or deep-rooting tree establishment that could breach the anoxic liner.

b | **Breach Penalty:** If the cap is breached and not repaired within 30 days, the vault loses its Anoxic status. The affected volume reverts to the standard Soil Decay Model (F_{perm}) based on local temperature, and the difference is quantified as an Avoidable Reversal.

c | **Legal Status Check:** Every 5 years, the Developer shall confirm via the Land Registry that the Restrictive Covenant remains active and registered on the land title.

16.4 | Reversal Reporting and Quantification

16.4.1 | **Notification Requirement** In the event of a confirmed Reversal (whether detected via monitoring or reported by stakeholders), the Activity Developer shall:

a | **Notify:** The Gold Standard Secretariat within 30 days of detection.

b | **Report:** Submit a Reversal Event Report detailing the cause (Avoidable vs. Unavoidable), affected area, and estimated carbon loss, utilising Equation 30 and the Damage Factors of Table 15 (Section 12.4 |).

c | **Compensate:** Proceed with cancellation from the Gold Standard compliance buffer (Unavoidable) or the direct purchase and retirement of replacement GSVERs (Avoidable), in strict accordance with Section 12.5 |.

16.5 | Data and Parameters Monitored

16.5.1 | The following parameters are specific to Reversal Monitoring and shall be recorded in addition to the parameters in Section 15|.

Parameter	Sentinel Status
Description	Verification status of a Sentinel Site during annual inspection (Track 1).
Data Unit	Categorical (Intact / Disturbed / Excavated)
Purpose of data	Systemic Breach Check (Enforcement of Section 12.5 | Aggregator Liability)
Monitoring Method	Visual field inspection utilising mobile application with geo-tagged/timestamped photographs.
Frequency	Annual (Statistical Sample Basis).
QA/QC	Aggregator shall provide photos for 100% of inspected Sentinel Sites in the selected sample cohort. If >5% of sites fail, a Systemic Breach is established (Section 12.5 |).

Parameter	Fire Index

Description	Remote sensing indicator of fire disturbance (Track 2/3).
Unit	Burned Area Index (BAI) or Active Fire Confidence.
Purpose of data	Reversal Quantification (Module A1 / Track 2 & 3)
Monitoring Method	Satellite Imagery (e.g., NASA FIRMS, Copernicus) mapped against project application polygons.
Frequency	Annual.
QA/QC	Cross-reference with local meteorological data to rule out false positives. Any overlap >5% area triggers mandatory ground-truthing to apply Table 15 Damage Factors.

Parameter	$Cap_{integrity}$
Description	Integrity status of the engineered cap sealing the Anoxic Storage vault.
Unit	Boolean (Intact / Breached)
Purpose of data	Verification of 0.95 Permanence Factor (Module A3)
Monitoring Method	Visual Site Inspection Report confirming the absence of subsidence, excavation, or deep-rooting vegetation penetrating the liner.
Frequency	Annually (during active Crediting Period).
QA/QC	Inspection report shall be signed by the Site Manager or a qualified Civil Engineer. If breached and unrepaired >30 days, F_{perm} reverts to local soil decay model.

17| APPLICATION TO PROGRAMME OF ACTIVITIES

17.1 | General Requirements

17.1.1 |The methodology is applicable to a **Programme of Activities (PoA)**. The Coordinating/Managing Entity (CME) shall demonstrate that the PoA complies with the *GS4GG Programme of Activities Requirements* and the specific constraints defined below.

17.1.2 |**VPA Consistency (Homogeneity):** A PoA may comprise multiple Voluntary Project Activities (VPAs). To ensure rigorous quantification and simplified verification, each VPA inclusion request shall be restricted to a single Compliance Track. A single VPA shall not mix Compliance Tracks (e.g., a VPA cannot combine "Track 1 Artisanal Kilns" and a "Track 3 Industrial Plant"). These shall be registered as separate VPAs within the PoA.

a | **Geographical Constraint:** Due to the country-specific nature of the Downward Adjustment Factor (DAF), a single VPA shall not span across national borders. Separate VPAs shall be registered for each Host Country.

b | **Scale Management (Track 1 VPAs):** The 60,000 tCO_2e/yr Track 1 threshold applies to each standalone activity or VPA and to related activities or VPAs assessed together under the de-bundling provisions of Section 3.2 |; no limit applies at the level of the PoA. The CME shall define distinct VPAs based on geographic areas or administrative zones to facilitate the Cross-VPA Sampling approach.

17.1.3 | **The CME Role (Aggregator):** For Track 1 and Track 2 VPAs, the CME assumes the role and liabilities of the Aggregator defined in Section 2. The CME is strictly liable for:

a | **Centralized Data Management**: Operation of the Digital Monitoring System (DMS) to track biomass sourcing and biochar distribution across all VPAs.

b | **Safety Compliance:** Ensuring all units within Track 1 VPAs adhere to the "No-Burn" and air quality safeguards (Section 3|).

c | **Benefit Sharing Execution:** Holding the strict financial liability for executing, logging, and reporting the mandatory Benefit Sharing Plan (Section 14.2 |) across all participating smallholder farmers.

17.2 | Baseline and Additionality Demonstration

17.2.1 | **Additionality:** Additionality shall be demonstrated at the level appropriate to the Track:

a | **Track 1 & 2:** Additionality may be demonstrated at the PoA Level if the CME defines a distinct eligibility class (e.g., "All Track 1 units in LDCs") that meets the Deemed Additionality criteria (Section 6.4 | Option A) or passes the barrier analysis under the pathway of Section 6.4 |, Table 7.

b | **Track 3:** Additionality shall be demonstrated at the VPA Level. Each Track 3 VPA inclusion shall include a specific Investment/Financial Viability Analysis (Section 6.4 |, Option C) for the specific industrial facility.

17.2.2 | Biomass Supply Shed (Leakage Prevention): To prevent multiple VPAs from competing for the same biomass resource (violating the Surplus Test, Annex 8 A8.4), the CME shall define a "Supply Shed" for each VPA.

17.2.2.1 | **Requirement:** The CME shall define each VPA's Supply Shed as the maximum geographical procurement radius around its production hub(s), consistent with Annex 8 (A8.4), and maintain a Supply Shed Registry mapping these radii.

17.2.2.2 | **Overlap Check:** New VPA inclusions shall not overlap with the Supply Shed of existing VPAs unless the CME demonstrates (supply-shed headroom assessment of the Surplus Test, Annex 8) that the combined aggregate

biomass demand of all overlapping VPAs does not exceed the total verifiable regional surplus.

17.3 | Monitoring and Sampling in PoAs

17.3.1 | **Cross-VPA Sampling (Track 1 & Small-scale Track 2):** For VPAs utilising Distributed or Mechanised units with homogenous technology and feedstock, the CME may utilise Two-Stage Sampling (Cross-VPA Sampling) as defined in the Article 6.4 methodological tool: Sampling and surveys (A6.4-AMT-010). This is subject to strict bifurcation rules:

17.3.1.1 | **Hierarchy:**

a. **Primary Stage:** Random selection of VPAs.
b. **Secondary Stage:** Random selection of Production Units or Sentinel Sites within the selected VPAs.

17.3.1.2 | **Condition:** Cross-VPA sampling is Prohibited if the VPAs operate in different climatic zones (affecting baseline decay/soil temp) or use different feedstocks (affecting biochar yield).

17.3.2 | **Track 3 Exclusion:** Cross-VPA sampling is prohibited for Track 3. Every Track 3 facility included in a PoA shall undergo individual verification (100% check) of its CEMS data, Weighbridge logs, and Lab reports.

18| RENEWAL OF CREDITING PERIOD

18.1 | Crediting Period Renewal Requirements

18.1.1 | The crediting period for activities under this methodology is 5 years. It may be renewed for a maximum of two additional periods (Total 15 years), subject to the successful reassessment of the baseline.

18.1.1.1 | **Exception:** Activities utilising Module F3 (Restorative Biomass) or Module F5 (Purpose-Grown) are limited to one renewal (Total 10 years) to prevent the perverse incentive of maintaining invasive species or degraded land solely for carbon revenue. (Note: The physical production facility may renew for a third period if the Activity Developer formally transitions the feedstock supply to an eligible waste/residue module [e.g., F1 or F2] and updates the project boundary accordingly).

18.2 | Reassessment of the Baseline Scenario

18.2.1 | At the time of renewal, the Activity Developer shall update the baseline parameters to reflect regulatory and economic changes in the Host Country.

18.2.1.1 | Regulatory Surplus Update: Because this methodology issues pure CDR credits, bans on baseline emissions (e.g., "No Open Burning" laws) do not affect the removals baseline (Section 6.2 |). The Activity Developer shall conduct a new Regulatory Surplus Analysis (Section 6.2 |) to determine whether the Host Country has legally mandated the specific production and durable application of biochar. Where the production and durable

application of biochar has become fully mandated and enforced, the activity is not eligible for renewal (Section 6.2 | and 7.5 |). Where a partial or unenforced mandate applies, the Crediting Baseline Removals shall be updated under Equation 3.

18.2.1.2 | Standardised Factors Update: For Track 1 and 2 activities utilising Annex 5 (Default Factors), the activity shall update all factors (Yield, Methane, Carbon Content) to the Latest Version of the methodology available at the time of renewal.

18.3 | Reassessment of Additionality

18.3.1 | The Activity Developer shall demonstrate Ongoing Financial Need (OFN) and repeat the Common Practice Analysis (Section 6.5 |) for the renewal period in accordance with the *GS4GG Requirements for Additionality demonstration*.

18.3.1.1 | **Long-Term Offtakes:** Binding, long-term carbon credit off-take agreements established prior to or during the first crediting period are evidence of ongoing financial need. Carbon credit revenues are strictly excluded from the renewal IRR baseline calculation and do not retroactively void additionality.

18.3.1.2 | **Track 1 & 2 OPEX Barriers:** For distributed and mechanised activities, the Activity Developer may demonstrate OFN by proving that carbon revenues remain essential to fund the continuous Aggregator MRV requirements, hardware replacement, and the active Benefit Sharing Plan payments to smallholders.

18.3.1.3 | **Commercial Viability Test (Track 3 & Large-Scale Track 2):** For all Track 3 Industrial facilities, and any Track 2 activities exceeding the 60,000 tCO_2e/yr large-scale threshold, the developer shall provide an updated Financial Viability Analysis (Section 6.4 |, Option C; Section 6.6 |) using actual operational costs and revenues from the previous period.

18.3.1.4 | Ongoing financial need: An activity shall not be penalised for temporary commodity price spikes. However, if the ex-post analysis demonstrates that the baseline market has fundamentally shifted and revenue strictly from physical biochar sales and energy/by-products (excluding carbon credits) is sufficient to meet the applicable financial benchmark over the preceding crediting period (Section 6.6 |), the activity is deemed Commercially Viable, loses its OFN, and is ineligible for renewal.

18.4 | Technology Graduation (Track 1 Sunset Clause)

18.4.1 | The methodology is designed for the biochar sector to mature from artisanal production towards mechanised and digitally verified production over successive crediting periods.

18.4.2 | Track 1 activities using manual kilns without digital verification are encouraged to transition to mechanised production (Track 2) or to digital kiln verification at renewal of the crediting period. Mandatory graduation requirements, including any hardship provisions, may be introduced at a

future revision of this methodology and will not apply retrospectively to activities registered under this version.

ANNEX -1| FEEDSTOCK MODULES & SUSTAINABILITY CRITERIA

This Annex defines the eligible sources of biomass for biochar production and mandatory sustainability criteria the activity developer shall meet to ensure that the sourcing of biomass does not result in deforestation, ecosystem degradation, toxic contamination, or leakage impacts. All feedstocks shall comply with the General Eligibility Criteria (Negative List) and the safeguards of the selected Feedstock Module.

A 1.1| Applicability

A 1.1.1| The Activity Developer shall categorize all biomass inputs into one of the six Feedstock Modules (F1–F6) and shall adhere to the Compliance Track restrictions of Section 3. The VVB shall utilise a standardised feedstock eligibility checklist to verify compliance with the Negative List and module-specific safeguards.

Table 17. Feedstock Module Applicability Matrix

Module	Description	Track 1 (Distributed)	Track 2 (Mechanised)	Track 3 (Industrial)
F1	Field Residues	Eligible	Eligible	Eligible
F2	Processing Residues	Eligible	Eligible	Eligible
F3	Restorative (Invasive)	Eligible	Eligible	Eligible
F4	Disaster/Sanitary	Restricted (Wildfire Only)	Eligible (Temp >500°C)	Eligible
F5	Purpose-Grown	Ineligible	Ineligible	Eligible
F6	Organic Waste	Ineligible	Ineligible	Eligible

Track 1 activities may use Module F4 only for wildfire fuel-load reduction consisting of small-diameter thinning (<10 cm) coordinated by a local forestry or emergency authority. The processing of pest-infected sanitary timber is prohibited under Track 1, which lacks the continuous thermal data-logging required to prove phytosanitary destruction. Mobile, in-field pyrolysis systems (e.g., mechanised field rovers processing F1 residues) are fully eligible provided they comply with Track 2 or Track 3 hardware and digital MRV requirements.

Under Track 1 the default methane factors of Annex 5, Table 22 apply only to woody biomass, grasses and herbaceous stems of ordinary density, maize cobs, and twigs and leaves. Other feedstock is eligible under Track 1 only with an activity-specific methane factor (Section 9.4 |, Option B).

A 1.2| General Eligibility Criteria (Negative List)

A 1.2.1| Regardless of the Feedstock Module selected, the following feedstocks are strictly prohibited across all tracks:

(1) **Fossil Carbon:** any feedstock containing non-biogenic carbon, including waste tires, rubber, plastics, synthetic textiles, or electronic waste. Track 3 exception: Municipal Solid Waste (MSW) containing fossil fractions is permitted under Module F6 only where the waste is physically segregated such that solely the verifiable biogenic fraction is utilised.

(2) **Peat:** biomass sourced from peatlands, histosols, or involving the drainage of wetlands.

(3) **Deforestation:** biomass obtained from the conversion of primary forests, High Conservation Value (HCV) areas, or land converted from forest to non-forest use after 31 December 2020 (aligning with EUDR). Ecosystem conversion: biomass obtained from the conversion, drainage or degradation of other natural ecosystems — including wetlands, peatlands, native grasslands and mangroves — after the same date is likewise excluded.

(4) **Treated Timber:** Waste wood treated with copper chrome arsenate (CCA), creosote, or paint containing lead/heavy metals, unless processed in a Track 3 facility with advanced flue gas cleaning complying with national industrial emissions regulations. The resulting biochar shall not be applied to soil (Module A1) and shall be directed only to Module A2 or A3 (no soil contact).

A 1.3| Feedstock Module Requirements:

The Activity Developer shall demonstrate compliance with the specific definitions and safeguards for the selected module.

A 1.3.1| Module F1: Agriculture & Forestry Residues

a. **Definition:** Biogenic residues generated during the harvesting of agricultural crops or forestry logging operations (e.g., straw, stover, stalks, logging slash, tops, branches) that are traditionally left on the field.

b. **Sustainability Safeguard (Soil Health):** A minimum of 70% of the residues by dry mass (default floor; raised on sloping, erosion-prone or coarse-textured soils) shall remain on the field in accordance with Annex 8; the maximum permissible removal is 30%.

A 1.3.2| Module F2: Processing Residues

a. **Definition:** Biogenic residues generated at a centralized processing facility. Examples: Rice husks, bagasse, nut shells, sawdust, fruit pits, olive pomace.

b. **Surplus Test:** The developer shall demonstrate, per Annex 8 that the residues are surplus and not committed to or in use for thermal energy, fodder/bedding, controlled composting, field mulching/soil return, or any material use.

A 1.3.3| Module F3: Restorative Biomass (Invasive Species)[2]

a. **Definition:** Biomass harvested from the removal of Invasive Alien Species (IAS) or bush encroachment vegetation to restore ecosystem function and water tables.

b. **Safeguard (perverse incentives)**: The target species shall be listed on a National or Regional Invasive/Weed List. Harvesting shall form part of a documented ecosystem restoration plan and cleared land shall not be replanted with the invasive species.

A 1.3.4| Module F4: Disaster Prevention & Sanitary Biomass

a. **Definition:** Biomass removed to mitigate verified risks of wildfire (fuel load reduction) or to control the spread of pests/disease (sanitary felling).

b. **Safeguard (Verification):** Thinning operations shall be authorised by the relevant National Forestry or Emergency Management Authority via a Fire Risk Assessment or Sanitary Felling Order. For pest-infected biomass, Track 2 and 3 production units shall provide continuous thermal logs proving the reactor maintained > 500 °C to ensure complete phytosanitary destruction.

A 1.3.5| Module F5: Purpose-Grown Biomass (Track 3 Only)

a. **Definition:** Crops cultivated specifically for biochar production (e.g., Miscanthus, Bamboo, Short Rotation Coppice). The cultivated species shall be verifiably native to the activity region, or a scientifically confirmed sterile hybrid where non-native; the introduction of potentially invasive non-native species for carbon-removal purposes is not permitted.

b. **Degraded Land Safeguard:** The Activity Developer shall demonstrate using remote sensing, historical land-use records, Participatory Rural Appraisal or equivalent evidence that each parcel was degraded, marginal or contaminated and was not in productive agriculture or grazing use on or after 31 December 2020 and before the start of cultivation.

A 1.3.6| Module F6: Organic Waste Streams (Track 3 only)

a. **Definition:** Biogenic waste streams requiring pathogen control, including animal manure, anaerobic digestate, sewage sludge (biosolids), and the organic fraction of MSW. Restricted to Track 3 (Industrial Precision) equipped with Continuous Emissions Monitoring Systems (CEMS) and advanced flue gas cleaning (e.g., scrubbers, electrostatic precipitators).

b. **Safeguard:** The pyrolysis process shall maintain a minimum temperature of 600°C for at least 15 minutes for the destruction of

[2] Strategic Alignment: Activities under this module are aligned with Target 6 of the Kunming-Montreal Global Biodiversity Framework (Minimize impact of invasive alien species).

biological pathogens. Treatment at this temperature does not establish the destruction of per- and polyfluoroalkyl substances (PFAS). Biochar produced from biosolids, manure, digestate or municipal waste may be applied to soil (Module A1) only where PFAS in the biochar has been analysed by an ISO 17025 laboratory and is below the limit applicable to soil amendments in the Host Country; where no such limit exists, the biochar shall be placed under Module A2 or Module A3.

c. **Safeguard: (^{14}C Fossil Deduction for MSW):** Track 3 facilities processing MSW shall conduct periodic radiocarbon (14C) testing (e.g., ASTM D6866 or EN 16640) on the final biochar product at the frequency set in Section 3.2 |. Issuance of CDR credits shall be pro-rated to the verified biogenic carbon fraction; the fossil carbon fraction is ineligible for crediting.

A 1.4| Feedstock Positive List (Deemed Compliance)

A 1.4.1| Biomass categories listed in the European Biochar Certificate (EBC) Positive List or the World Biochar Certificate (WBC) Positive List are deemed eligible under Module F1 or F2, provided they meet the definition of "biogenic residue." The activity developer shall cite the specific EBC/WBC reference. This feedstock positive list is distinct from the Additionality Positive List (LDC / SIDS) of Section 6.4 |.

A 1.5| Evidence Requirements

A 1.5.1| The activity developer shall collect and archive the following evidence to verify feedstock eligibility during the annual audit

Table 18. Evidence Requirements

Module	Required Evidence	Frequency
F1 (Field)	Geo-tagged photos of harvest area; Agronomic calculation of retention rate or open-burning baseline evidence. (retention floor per Annex 8 A8.5)	Annual Sample
F2 (Processing)	Letter of Origin from the facility; Weighbridge tickets; Surplus Test justification (Annex 8 A8.4, A8.9)	Monthly Aggregated
F3 (Invasive)	Botanical ID of species; Reference to National Invasive List; Restoration Plan.	Design Certification / Ex-Ante
F4 (Disaster)	Written authorization/order from Forestry/Fire Authority.	Per Harvest Event
F5 (Crops)	Soil survey, Land Classification, or Yield / remote-sensing records evidencing the Annex 8 A8.8.2 land condition.	Design Certification/ Ex-Ante

F6 (Waste)	Waste transfer notes; Lab analysis of input (if MSW/Sludge); Temperature logs (> 600 °C).	Per Continuous Lot / Batch

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ANNEX -2| REQUIREMENTS FOR TRAINING, CAPACITY BUILDING & OPERATIONS

This Annex defines the minimum operational standards, health and safety protocols, and capacity-building requirements for activity developers, to ensure occupational safety, environmental protection, and accurate MRV data collection.

A 2.1| Applicability:

A 2.1.1| The activity developer shall submit a Training Plan at the time of design certification. The implementation of this plan is mandatory and differentiated by Compliance Track:

a|. **Track 1 (Distributed):** a "Train-the-Trainer" model covering artisanal safety, manual process control (e.g., flame curtain operation), Benefit Sharing, and digital literacy for decentralised monitoring.

b|. **Track 2 (Mechanised):** operator certification focusing on semi-automated machinery operation, maintenance of thermal proxies, and industrial safety.

c|. **Track 3 (Industrial):** deemed compliant with health and safety requirements of this annex where the facility operates under a valid, internationally recognised occupational health-and-safety certification (e.g., ISO 45001) or strict national industrial safety audits (e.g., OSHA). Track 3 facilities nonetheless remain subject to Module T3 (Digital MRV & Compliance).

A 2.2| Standard Operating Procedures (SOPs)

A 2.2.1| Before the start of the Crediting Period, the activity developer shall develop and document comprehensive Standard Operating Procedures (SOPs).

A 2.2.2| Language & Visual Accessibility: For manual and semi-mechanised systems (Track 1 & 2), SOPs and training materials shall be translated into the local dialect and rely on highly visual/pictographic guides to accommodate varying literacy levels. Waterproof safety placards using universally recognised hazard symbols shall be posted at operating site.

A 2.3| Training Curriculum

A 2.3.1| The activity developer (or the Aggregator for Track 1) shall implement a training program ensuring all operators possess the necessary competency.

A 2.3.2| Module T1: Health, Safety & Environment (HSE) (Track 1 & 2):

a|. **Fire Safety:** Establishment of "Exclusion Zones" (min. 3 meters) around hot kilns, maintenance of firebreaks, and use of fire extinguishers/water buckets.

b|. **Respiratory Protection (Dust vs. Smoke)**:

i. **Dust Hazard:** proper use of N95/P2 particulate respirators exclusively during the unloading, crushing, screening, and bagging phases to prevent fine particulate and silica inhalation.

ii. **Smoke Hazard:** Education that N95 masks do not filter Carbon Monoxide (CO) or toxic pyrolysis gases; Smoke inhalation is prevented via strict windward operation (working upwind of the smoke plume) and proper thermal process control.

c|. **CO and smoke Exposure:** Awareness of carbon monoxide risks; indoor operation of unvented units is strictly prohibited.

d|. **PPE Usage:** Proper use of Personal Protective Equipment (PPE) including heat-resistant gloves, N95/P2 particulate masks, safety goggles and closed-toe footwear.

e|. **First Aid**: Basic treatment protocols for thermal burns and smoke inhalation.

A 2.3.3| Module T2: Production Technology

a|.Track 1 (Artisanal):

i. Feedstock-moisture management: Operators shall be trained to dry feedstock to 24% moisture or less (wet basis) before charging — batches above 24% are not creditable, and the lowest factor of Table 22 applies only at 15% or less (Section 9.4 |). Training shall cover practical moisture assessment and the drying and storage practices needed to reach and hold the target prior to pyrolysis.

ii. Track 1 (artisanal): Visual identification of the "Ash Layer" (indicating complete carbonization); management of the pyrolysis front to prevent smoke events; quench point to maximise stability. Production shall meet the certified test-burn / thermal-compliance requirement (Section 3.2 |)

b|. **Track 2 (Mechanised):** Machine loading rates to prevent jamming; Thermal Proxy Management (monitoring temperature gauges and procedures for manual recording during data Logger failures); and routine maintenance (e.g., cleaning air injection nozzles).

A 2.3.4| Module T3: Digital MRV & Compliance (All Tracks):

a|. **Device Training:** Operation of the mobile tracking applications, weighbridge software, or facility dashboards.

b|. **Evidence Collection:** Protocol for clear, fraud-resistant photographs (incorporating a timestamp or reference object), including the proof-of-incorporation requirement of Section 12.3 (geo-tagged, time-stamped photographs for every batch; for Tracks 2 and 3 also the Attestation of Incorporation of Annex 3, Module A1).

c|. **Weighing Protocol:** Correct procedure for taring scales and recording Net Weight and adherence to the Composite Sampling limits defined in Annex 4 without cross-contaminating feedstocks.

A 2.3.5| Module T4: Social Safeguards - "No-Burn" Rule: (Track 1):

a|. **Education:** Clear instruction that biochar produced for carbon crediting shall never be diverted for use as heating or cooking fuel.

b|. **Economic Logic:** Training shall demonstrate the agronomic value proposition (yield increase + carbon payment > Charcoal Price) to reinforce social permanence.

A 2.4| Capacity Building and Competency Assessment

A 2.4.1| "Train-the-Trainer" Model (Track 1): To scale distributed networks effectively, the activity developer shall use a hierarchical training structure. Master Trainers (technical experts employed by the developer) → Community Trainers (local leaders overseeing clusters of producers) → Producers (individual farmers operating the kilns).

A 2.4.2| Competency Verification: Training effectiveness shall be verified before authorisation of any operator to generate credits.

a|. Operators shall pass a practical exam (demonstrating safe ignition and quenching) and a theoretical check (safety rules).

b|. Refresher training shall be repeated annually or whenever a significant change in SOPs occurs.

A 2.4.3| Gender and Social Inclusion: In accordance with GS4GG Gender Equality Requirements: training sessions shall be scheduled at times and locations accessible to women and marginalised groups, accounting for local agricultural labour cycles and domestic responsibilities**;** training materials shall rely on visual aids to accommodate varying literacy levels; and PPE provided shall include sizes appropriate for all workers, including women.

A 2.4.4| Benefit-Sharing and FPIC: The Train-the-Trainer programme and community engagement shall reflect the Benefit-Sharing arrangements of Section 14.2 and the Free, Prior and Informed Consent (FPIC) requirements of the GS4GG Safeguarding Principles and Requirements.

A 2.5| Operational Equipment Requirements

A 2.5.1| Personal Protective Equipment (PPE): The activity developer shall provide (or verify the possession of) the following minimum PPE for all workers:

a|. **Respiratory Protection:** Masks rated for fine particulate matter (e.g., N95) during reactor unloading, crushing, and bagging.

b|. **Thermal Protection:** Heat-resistant gloves for handling hot equipment.

c|. **Eye Protection:** Safety goggles to prevent ash/spark injury.

d|. **Foot protection**: Closed-toe footwear

A 2.5.2| Safety Infrastructure

a|. **Fire Breaks:** A cleared perimeter of at least 3 meters around open-air kilns (Track 1) cleared of flammable vegetation.

b|. **Water Access:** Immediate availability of at least 200 liters of water (or sand equivalent) per unit for emergency suppression or 0.5 cubic meters of loose mineral sand/soil (for arid contexts or enclosed retorts where introducing water presents an extreme steam-expansion explosion hazard) per active unit for emergency smothering.

ANNEX -3| ELIGIBLE END-USE APPLICATION MODULES

This annex defines the eligible sinks for the durable storage of biochar and the quality, application-restriction and chain-of-custody requirements the activity developer shall meet to generate VERs.

A 3.1| Applicability

A 3.1.1| The activity developer shall select the applicable module(s) at the time of Design Certification subject to Compliance Track restrictions of Table 19.

Table 19. Module Applicability Matrix

Module	Description	Track 1 (Distributed)	Track 2 (Mechanised)	Track 3 (Industrial)
A1	Soil Application	Eligible	Eligible	Eligible
A2	Engineered Materials	Ineligible	Eligible	Eligible
A3	Dedicated Earth Vaults (subterranean or above ground)	Ineligible	Eligible	Eligible

Modules A2 and A3 apply the fixed Permanence Factor of 0.95 under Method 3 (Section 8.5), subject to the physical-integrity safeguards in Section 12. These physical-integrity conditions are application requirements and apply regardless of the permanence method elected. Module A1 applies the temperature-dependent permanence of Method 1 (Annex 6) or, where elected, Method 2 (Annex 4).

A 3.2| Module A1: Soil and Land Application

A 3.2.1| Scope: Application of biochar to soil systems to durably enhance soil organic carbon stocks, improve agronomic fertility, or remediate contamination.

A 3.2.2| Eligible Sinks: Agricultural cropland, pasture/rangeland, agroforestry systems, commercial forestry, urban green infrastructure (e.g., parks, bioswales), and remediation sites (e.g., mine tailings, brownfields).

A 3.2.3| Ineligible Sinks: Application to sensitive ecosystems (e.g., native peatlands, histosols, protected wetlands, undisturbed native grasslands) is prohibited.

A 3.2.4| Technical & Safety Requirements:

a|. **Contamination thresholds:** Biochar applied shall comply with the contaminant limits (Pb, Cd, Hg, As, Cu, Zn, Ni, Cr; PAHs, Dioxins and furans, PCDD/F) of the European Biochar Certificate (EBC) "Agro" class, the International Biochar Initiative (IBI) standard, or national fertiliser regulations/ soil-amendment limits - whichever is most stringent for receiving jurisdiction.

b|. Testing requirements follows the feedstock module, not the Track label:

i. Clean biomass (Feedstock modules F1, F2, F3, F5): heavy-metal and PAH compliance demonstrated via composite sampling (Annex

4). PCDD/F and PCB testing applies where the trigger in Section 3.4 is met (production below 500 °C, or high-chlorine or waste-derived feedstock).

ii. **High-risk feedstocks** (Module F4 sanitary timber; Module F6 organic waste, MSW, biosolids): Full, batch-specific ISO 17025 laboratory screening for Heavy Metals, PAHs, and PCDD/F prior to land application by the analytical methods of Annex 4.

This tiering is consistent with the Annex 1 contamination routing: any treated-timber (F4) or contaminated stream that fails the A1 contaminant thresholds shall be diverted to Module A2 or A3 (no soil contact), not applied to soil.

A 3.2.5| Application Protocols & Safeguards

a|. **Incorporation vs. Surface Application:** Biochar should ideally be physically incorporated into the root zone (top 10–30 cm) via ploughing, harrowing, or precision planting pits to minimise wind erosion and surface oxidation. Surface application (top-dressing) without physical incorporation is fully permitted for no-till agriculture and broad-acre forestry; however, surface-applied biochar carries the higher wildfire Damage Factor of Table 15 (Section 12.4 |), reflecting its greater exposure.

b|. **Agronomic Volume Caps:** To protect smallholder food security from sudden pH shocks or nutrient immobilisation, the application rate shall not exceed 50 metric tonnes of dry biochar per hectare per application on any field, calculated as a field-level broadcast average— consistent with the application limits of Section 3.4. Precision / root-zone placement is assessed on the placed area.

c|. **Remediation Exemption (Section 3.4):** Certified brownfield or mine-tailing remediation sites are exempt from the 50 t/ha cap, where a qualified environmental engineer or agronomist verifies that the elevated rate safely immobilise toxicants.

A 3.2.6| Evidence of Application

a|. **Track 1:** Geo-tagged, time-stamped photographs of the application event for every credited batch (Section 12.3 |; PARC 21).

b|. **Track 2 & 3:** signed weighbridge tickets citing the location (GPS) and quantity; spatial polygon data (KML/Shapefiles) of the treated boundaries; and a signed Attestation of Incorporation confirming the field application (not stockpiling).

A 3.3| Module A2: Engineered Materials (Built Environment)

A 3.3.1| Scope: Encapsulation of biochar into long-lived, non-soil construction or industrial materials, where mineral matrix protects the carbon from oxidative decay.

A 3.3.2| Eligible Sinks: Inert mineral, cementitious or bituminous matrices, including structural and non-structural concrete, asphalt binder and base courses, plaster/mortar and fired masonry bricks. Ineligible: asphalt surface

(wearing) courses, unbound pavement layers and bituminous surface treatments. The placement layer shall be evidenced for every batch.

A 3.3.3| Ineligible Sinks: Biochar shall not be integrated into combustible matrices, including plastic-wood composites, polymers, resins, or drywall/gypsum paper boards. Single-use packaging and fuel pellets are prohibited.

A 3.3.4| Structural Integrity: Biochar inclusion shall not compromise the structural safety of the host material. The Developer shall ensure the downstream manufacturer complies with relevant structural performance standards (e.g., ASTM C1919-22 for biochar in cementitious composites).

A 3.3.5| Prohibition of Kiln Fuel: In B2B concrete or asphalt applications, biochar shall be used as an aggregate/filler in the final mixing phase. Diversion of biochar into cement kilns to be burned as an alternative fuel is prohibited; any such volume is ineligible for crediting and, where already issued, is an Avoidable Reversal (Section 12.5).

A 3.3.6| Permanence and Safeguards (A2)

a|. **Permanence:** Module A2 applies the fixed Permanence Factor of 0.95 under Section 8.5, Method 3, and the fixed reversal rate in Annex 7, Table 25. No separate end-of-life tracking is required. The Permanence Factor and the reversal rate are distinct provisions and are not netted against one another.

b|. **Assignment of Rights:** To prevent double-counting, the developer shall obtain a contractual assignment of rights from the material manufacturer confirming that the carbon removal attribute is retained by the activity and shall not be claimed in the manufacturer's Environmental Product Declaration (EPD) or Corporate GHG Inventory.

A 3.3.7| Evidence of Application (A2 documentation **checklist):** For each biochar batch directed to Module A2, the activity developer shall archive:

a|. Signed B2B sales invoices linking the specific biochar batch IDs to material manufacturer;

b|. the executed Assignment of Rights (EPD / inventory exclusion);

c|. confirmation that the receiving matrix is non-combustible (mineral, cementitious or bituminous); and

d|. evidence of structural-standard compliance (ASTM C1919-22 or equivalent).

A 3.4| Module A3: Engineered Anoxic Storage

A 3.4.1| The permanent storage of biochar in engineered, oxygen-limited environments where oxidative decay is physically prevented. Module A3 is restricted to Tracks 2 and 3.

a|. **Eligible Sinks:** Subterranean Dedicated Earth Vaults (DEVs), subterranean or above-ground (see below). Active or capped methanogenic MSW landfills are strictly excluded.

A 3.5| Technical Requirements:

A 3.5.1| Storage shall be in a Dedicated Earth Vaults that is subterranean (buried at least 2 meters below grade), separated from seasonal high-water table by at least 1.5 meters clearance, dedicated purely to biochar (no mixed organic waste), and permanently sealed with an impermeable cap, the liner and cap having a hydraulic conductivity not exceeding 1×10^{-9} m/s. Where subterranean burial cannot meet the 1.5 m water-table clearance, an above-ground/raised engineered vault may be used as an A3 sub-type provided it preserves equivalent containment (impermeable liner; sealed low-permeability cap maintaining anoxia; binding restrictive covenant) and is supported by a geotechnical/hydrological justification.

A 3.5.2| Permanence and Safeguards (A3):

a|. **Permanence:** Module A3 applies a fixed F_{perm} = 0.95 (Section 8.5 |, Method 3; Annex 6), provided the physical-integrity safeguards of Section 12| are met.

b|. **Safeguards (all of the following)**:

i. **Denaturing (Economic Safeguard):** Prior to or during burial, the biochar shall be physically mixed with low-value native soil, heavy clay, or raw manure. Denaturing destroys the biochar's commercial value as a clean heating fuel, permanently removing the economic incentive for future actors to excavate it.

ii. **Legal Restrictive Covenant:** The storage site footprint shall be geo-fenced. The land title shall be subject to a Legal Restrictive Covenant (or equivalent notation) prohibiting excavation for not less than the credited durability period (200 years); where fee-simple deed restrictions are legally unavailable (e.g. customary or state-owned land), an equivalent enforceable instrument shall be used.

iii. **Monitoring and reversal:** Cap integrity shall be monitored. On an unrepaired cap breach beyond 30 days, F_{perm} reverts to the Method 1 soil-decay value at the local MAST, and the difference — the damage factor $(0.95 - F_{permMAST}) / 0.95$ — is recorded as an Avoidable Reversal (Section 12.4 |; Table 15; Section 12.5 |). Cessation of monitoring is likewise treated as an Avoidable Reversal.

A 3.5.3| Evidence Requirements (A3)

a|. **Geotechnical Proof:** a geotechnical bore log or certified hydrological survey submitted prior to construction proving the 1.5-meter water table clearance.

b|. **As-Built Survey:** a surveyor report confirming the GPS boundaries, depth, and volume of the burial cell.

c|. **Engineering Certification:** Validation of the cap integrity and liner installation by a qualified civil engineer.

ANNEX -4| LABORATORY TESTING & ANALYTICAL METHODS

This annex specifies the sampling, accreditation and analytical methods supporting the carbon, stability, durability and safety determinations of the methodology. Section references are to the methodology body.

A 4.1| Sampling and Compositing (Track 1 & 2)

A 4.1.1| To support decentralised operations, Track 1 and Track 2 activities may aggregate physical sub-samples across production units into representative, homogenous Composite Master Samples prior to laboratory submission.

a|. **Homogeneity Constraint:** Compositing is limited to biochar produced from the same feedstock class of Annex 5, Table 21. Mixed feedstocks shall be separated into distinct composite samples.

b|. **Track 1 Limit:** A Master Sample shall represent a maximum of 50 metric tonnes of production, or one calendar month (whichever occurs first). Track 1 activities using the conservative default factors of Annex 5 are not required to test each Master Sample for $Corg/H{:}Corg$; where a Track 1 activity elects to test, the protocol of this Annex applies.

c|. **Track 2 Limit:** A Master Sample shall represent a maximum of 100 metric tonnes of production, or one calendar month (whichever occurs first).

A 4.2| Laboratory Accreditation Equivalency

A 4.2.1| Formal laboratory analysis shall be conducted by an independent ISO 17025 accredited laboratory.

a|. **LDC Exemption:** Where no ISO 17025 accredited laboratory capable of required biochar analysis exists within the Host Country, the activity developer may use a national university laboratory or a government-certified agricultural testing facility, provided the VVB audits its internal QA/QC and confirms method competence.

A 4.3| Analytical Standards for Stability (Method 1 inputs)

A 4.3.1| To calculate the molar $H{:}Corg$ ratio without corrupting the hydrogen determination, laboratories shall follow this protocol:

a|. **Moisture Content (MC):** Determined via standard gravimetric oven drying (e.g., ASTM D1762 or ISO 18134). Thermogravimetric Analysis (TGA) is not required for the moisture determination — but is required for the reactive-fraction discount in Method 2 (Section 8.5 |).

b|. **Total Hydrogen (H):** Analysed via Ultimate Elemental Analysis (CHNO-S) on a rigorously dried, untreated (non-acid washed) raw biochar sample.

c|. **Organic Carbon ($Corg$):** Total Carbon (C_{tot}) shall not be used to calculate sequestration unless the biochar is verified to contain negligible carbonates (<2% mass). Otherwise, C_{org} shall be determined either by

quantifying and subtracting Total Inorganic Carbon (TIC) (e.g., via calcimetry), or by performing an equivalent verified method.

d|. **Thermal compliance measurement (Section 3.2.4; Section 9.4):** Temperature shall be measured with a type K or type N thermocouple, or an equivalent sensor of accuracy class 1 (±1.5 °C or ±0.4% of reading), placed in the carbonisation zone for the 450 °C minimum (Section 3.2.4) and at the outlet of the secondary combustion chamber for the thermal proxy (Section 9.4). Readings shall be logged at intervals of 60 seconds or less under Track 2 and Track 3 and at least once per firing cycle under Track 1, time-stamped and retained with the batch record. Sensors shall be calibrated according to the manufacturer's specification or annually, whichever is more frequent (Section 13.4 |), and thermocouples used for the Track 2 thermal proxy or in Track 3 reactors are additionally inspected, recalibrated or replaced at least every six months (Section 15.1 |); a reading more than 50^0C from the lot set point starts a new production lot (Section 8.3 |). Residence time for the thermal proxy is determined from the chamber volume and the measured flue-gas flow and shall be documented in the PDD.

A 4.4| Method 2: Inertinite Petrography (1,000-Year High Durability)

A 4.4.1| Status: Method 2 is available to Track 2 and Track 3 activities. An activity shall apply a single durability basis per biochar batch: where Method 2 is elected, only the qualifying inertinite fraction is credited, and the non-qualifying fraction is not additionally credited under Method 1. The choice shall be stated in the PDD.

A 4.4.2| **Protocol:** Laboratories shall determine the inertinite fraction by random-reflectance petrography under oil immersion following ISO 7404-5:2009 or ASTM D2798, reporting reflectance at the maceral level. A minimum of 500 reflectance measurements shall be made across at least three replicate samples of the biochar batch, and the full histogram of reflectance values shall be submitted at verification.

A 4.4.3| **Reactive-fraction discount.** Consistent with Sanei et al. (2024), only the recalcitrant carbon fraction shall be credited. The thermally-reactive (labile) fraction shall be determined by thermogravimetric analysis (TGA) and excluded before the reflectance fraction is applied.

A 4.4.4| **Quantification:** The credited 1,000-year durable fraction is the recalcitrant inertinite fraction — the percentage of recalcitrant pyrogenic organic - carbon particles exhibiting a Random Reflectance (Ro) of ≥ 2.0%— taken at a conservative lower bound of one sample standard deviation below the mean across the replicate measurements:

$$F_{perm,i} = MAX(0, MIN(0.95, (R_0 - s_R_0) \times (\bar{C}_nr - s_C)))$$

$$S = \sqrt{\left[(1/(n-1)) \times \sum (X_i - \bar{X})^2\right]}$$

where $\bar{R}_0$ is the mean recalcitrant inertinite fraction and sR_0 its sample standard deviation across the replicate measurements, and $\bar{C}nr$ is the mean

non-reactive carbon fraction after the TGA exclusion above and sC its sample standard deviation. The result is the Method 2 permanence factor of Equation 8 (Section 8.5 |), reproduced here, and supersedes the temperature-dependent decay model for the qualifying carbon.

A 4.5| Tiered Testing Framework (Track 3 Cost Optimisation)

A 4.5.1| Baseline calibration phase: Full Ultimate Analysis (CHNO-S) is required during initial baseline calibration.

A 4.5.2| Routine monitoring phase: For steady-state continuous production using the same feedstock and temperature profile, the facility may rely on high-frequency, proximate analysis (fixed carbon via ASTM D1762) as a daily/weekly QA/QC proxy for $Corg$.

A 4.5.3| Rigour safeguards: The proxy correlation between fixed carbon and $Corg$ shall demonstrate a coefficient of determination (R^2) of ≥ 0.90. The proxy shall be cross-calibrated against a full ultimate analysis at an external ISO 17025 laboratory at least annually, and a new baseline calibration shall be triggered on any change of feedstock or a process-temperature shift greater than 50^0C.

A 4.6| Toxicity Testing Standards (Module A1)

A 4.6.1| For Module A1 (soil) agricultural safety, laboratories shall use following digestion and detection protocols:

a|. **Heavy Metals:** Acid Digestion (EPA 3050B, EN 13650, or ISO equivalent) then to ICP-MS or ICP-OES detection. Applicable to All Module A1 (soil) activities.

b|. **Polycyclic Aromatic Hydrocarbons (PAHs – 16 EPA priority)**: Laboratories shall utilise 100% Toluene Soxhlet extraction (e.g., EPA 3540C for 36 hours) or DIN EN 16181 protocols, followed by GC-MS detection (e.g., EPA 8270). Applicable to All Module A1 (soil) activities.

c|. **Dioxins & furans (PCDD/F):** Isotope-dilution HRGC-HRMS (EPA 1613B / EPA 8290 / EN 16190), reported as WHO toxic equivalents (WHO-TEQ). Mandatory for Track 3 high-risk feedstocks (Module F6 organic waste; sanitary Module F4) per Annex 3. Required for any activity meeting the Section 3.4 trigger (production below 500 °C, or high-chlorine or waste-derived feedstock). PCBs: EPA 1668 or EN 16167 on the same extract.

ANNEX -5| CONSERVATIVE STANDARDISED FACTORS FOR TRACK 1 & 2

A 5.1| Biochar Production Parameters (Track 1)

A 5.1.1| Default Yield Factors ($Y_{default}$): Used in Section 8.3 | to back-calculate dry biomass input from weighed biochar output when direct weighing of raw inputs is unfeasible. Each class is set at the 10th percentile of field-measured flame-curtain yields on woody feedstock, applied to every class as a lower bound. Yields are expressed per tonne of dry feedstock and assume biochar carbonised to satisfy the $H{:}C_{org} \leq 0.4$ eligibility screen (Section 3.2 |, Track 1).

Table 20. Conservative Biochar Yield Factors

Feedstock class	$Y_{default}$ (t char / t dry feed)	Y_{max} ceiling (sanity flag)	Basis
Woody biomass — branches, prunings, stems	0.15	0.32	10th percentile and maximum of field-measured flame-curtain yields on woody feedstock
Nutshells, stones and fruit pits	0.15	0.42	Lower bound of the woody distribution; ceiling from dense-precursor char yields
Herbaceous and other crop residues — straw, stover, grass, leaves, bagasse	0.15	0.38	Lower bound of the woody distribution; no separate field data
Rice husk and high-silica husks	0.15	0.50	Lower bound of the woody distribution; high ceiling reflects retained biogenic silica
Manure and biosolids	not applicable	—	Module F6 is restricted to Track 3, which determines yield by direct measurement

A 5.1.2| The high ceiling of the siliceous class is not a high carbon yield: its low organic-carbon content is applied separately through Table 21, so mass and carbon are never conflated. For carbon accounting, nutshells/stones take the woody C_{org}, bagasse and other fibrous residues the standard-herbaceous C_{org}, rice husk the high-silica C_{org}, and manure/biosolids the dedicated low-carbon C_{org} set out in Table 21.

A 5.1.3| Co-processed (blended) feedstocks: Where a single production batch carbonises a documented blend, the applicable factor is the dry-mass-weighted mean of the component factors:

$$Y_{blend} = \frac{\sum_i (m_i Y_i)}{\sum_i (m_i)}$$

where m_i is the dry mass of component i in the batch and Y_i its tabulated factor; the same weighting yields the blended sanity-flag ceiling $\boldsymbol{Y_{max,blend}}$. Where the blend composition is not documented to within ± 10% by dry mass, the lowest component $\boldsymbol{Y_{default}}$ (and lowest $\boldsymbol{Y_{max}}$) in the blend shall be applied, this being the conservative choice in both directions of use.

A 5.1.4| Mass-balance sanity flag (feedstock-specific). Independently of the back-calculation in Section 8.3 |, the ceiling Y_{max} provides a plausibility check on declared output. Where both biochar output and dry feedstock input are recorded for a batch, the implied yield — tonnes of biochar weighed divided by tonnes of dry feedstock recorded — shall not exceed Y_{max} for the declared class (or $Y_{max,blend}$):

$$M_{biochar}/M_{dryfeed} \leq Y_{max}\ (declared\ class)$$

An implied yield above the ceiling signals a physical inconsistency — over-stated biochar mass, under-stated or mis-recorded feedstock, wet feedstock counted as dry, or a mis-declared feedstock class. The affected batch is quarantined for verification and excluded from crediting until the discrepancy is reconciled. Each ceiling is set at the upper bound of eligible-temperature char yields reported for its class.

A 5.1.5| Default Organic Carbon Content (C_{org}): Used in Section 8.4 | where laboratory analysis is not performed (Track 1; Track 2 where selected). Each Table 20 feedstock class maps to the Table 21 category of the same name. Mixed feedstock takes the default of its lowest-carbon component unless the blend composition is documented to within ±10% by dry mass, in which case the dry-mass-weighted mean applies.

Table 21. Conservative Organic Carbon Content

Feedstock category (Table 20 class)	Default Corg (decimal)	Basis
Woody biomass	0.55	10th percentile of the IPCC (2019) pyrolysis distribution for wood (mean 0.77 ± 42%)
Nutshells, stones and fruit pits	0.55	10th percentile for nut shells, pits and stones (mean 0.74 ± 39%)
Herbaceous and other crop residues, bagasse	0.45	10th percentile for herbaceous biomass excluding rice (mean 0.65 ± 45%)

Rice husk and high-silica husks	0.35	10th percentile for rice husk and straw (mean 0.49 ± 41%)
Animal manure	0.25	10th percentile for manure (mean 0.38 ± 49%); informative only — Module F6 is restricted to Track 3, which measures the organic carbon
Biosolids	0.25	10th percentile for biosolids (mean 0.35 ± 40%); informative only — Module F6 is restricted to Track 3, which measures the organic carbon

A 5.2| Activity Methane Emission Factors ($EF_{CH4,tech}$)

A 5.2.1| These factors are used to quantify process methane slip. The standard factors apply to Track 1 by feedstock moisture class; the excursion penalty applies to Track 2 activities only when thermal destruction proxies fail.

Table 22. Technology Methane Slip Factors (moisture-conditioned)

Technology class and feedstock moisture class (wet basis, at charging)	Emission factor (t CH_4 / t dry biochar)	Basis
Flame-curtain kiln, dry feedstock ≤ 15%	0.0055	Quantification limit of the field measurements; every dry-class measurement below 5 g/kg
Flame-curtain kiln, semi-moist feedstock > 15% to 24%	0.020	Highest value measured in the semi-moist class
Flame-curtain kiln, moist feedstock ≥ 24%	not creditable	Feedstock shall be dried to 24% or less before charging
Top-lit updraft (TLUD) gasifier, any moisture	no default	Activity-specific factor under Section 9.4, Option B
Thermal excursion penalty (Track 2)	0.150	Batches produced while the secondary combustion chamber is below 850 °C; stoichiometric worst case

Moisture is measured with a calibrated handheld meter at charging and recorded for every batch (Annex 4); the batch takes the factor for its moisture class. The flame-curtain factors apply only to woody biomass, grasses and herbaceous stems of ordinary density, maize cobs, and twigs and leaves. Fine or dense residues with restricted airflow (husks, pomace, nut-shell fines, sludges) and TLUD units require an activity-specific factor under Section 9.4, Option B.

A 5.3| Standardised Deductions & Application Losses

A 5.3.1| This section standardises lifecycle operational deductions, including the moisture capacity of biochar resulting from kiln quenching operations.

Table 23. Standardised Deduction Factors

Parameter	Description	Value	Unit	Application
$EF_{embodied}$	Infrastructure Emissions (Track 1)	0.02	tCO_2e per t dry biochar	Steel of the kiln, amortised over the first crediting period; bounding case of a 1 m³ steel cone at low utilisation (basis below Table 23).
$EF_{embodied}$	Infrastructure Emissions (Track2)	0.05	tCO_2e per t dry biochar	Steel and concrete of a mechanised unit, amortised over the first crediting period; bounding case of a 1 t/day unit (basis below Table 23).
$MC_{deduct,dry}$	Moisture Deduction (air- or snuff-quenched; soil- or smother-quenched)	0.15	Fraction	Air- or snuff-quenched (including soil- or smother-quenched) biochar only, where a meter reading is unavailable; water-quenched biochar has no default.
$MC_{deduct,water}$	Moisture Deduction (Water Quenched)	not applicable	Fraction	Water-quenched biochar shall be metered; no default.
$L_{app,manual}$	Application Loss (precision manual)	0.02	Fraction	2% loss during manual transport/spreading.
$L_{app,surface}$	App loss (Mechanised surface)	0.05	Fraction	5% loss during mechanised surface spreading / tilling.
$L_{app,material}$	App Loss (Module A2 / A3)	0.01	Fraction	1% transit/spillage loss before encapsulation or burial.

Basis of the embodied-emission defaults. The defaults bound the embodied emissions of the production unit per tonne of dry biochar over the first crediting period, taking the smallest unit at the lowest utilisation admitted under each track. Track 1: a 1 m³ steel flame-curtain cone of about 80 kg, at 1.91 t CO_2 per tonne of steel, gives 0.15 t CO_2e; at 130 kg of feedstock

per run, a 22 per cent yield (about 29 kg of biochar per run) and 100 runs per year over five years, the unit produces about 14 t of biochar, giving 0.011 t CO_2e per tonne; the default is set at 0.02. A 2 m³ cone producing 500 kg per run gives under 0.003. Track 2: a mechanised unit of 1 t dry biomass input per day, with about 5 t of steel and 5 m³ of concrete (0.35 t CO_2 per m³), gives about 11 t CO_2e; at 0.2 t of biochar per day over 250 days per year for five years (250 t), 0.045 t CO_2e per tonne; the default is set at 0.05. Larger units give lower values. Electronic and ancillary equipment is below the materiality threshold of Section 9.1. An activity whose unit is heavier or less utilised than these bounding cases shall apply Option B.

A 5.4| Small-Hub Pre-Processing Default ($EF_{preproc}$)

A 5.4.1| A small processing hub is a centralised facility that chips, grinds, screens and/or dries feedstock for Track 1 or Track 2 production, with a rated throughput at or below 15 tonnes of feedstock per day — the capacity boundary between the mechanised (Track 2) and industrial (Track 3) tracks. A facility exceeding this boundary operates at industrial scale and shall apply facility-specific energy accounting in full, consistent with Track 3 monitoring.

A 5.4.2| Where an activity sources feedstock from a small processing hub, pre-processing emissions shall be quantified as: $PF_{PP,y} = M_{hub,y} \times EF_{preproc}$

where $PF_{PP,y}$ are the pre-processing emissions in year y (tCO_2e), $M_{hub,y}$ is the dry mass of feedstock processed through the hub and used by the activity in year y (t), and $EF_{preproc}$ is the default pre-processing emission factor: $EF_{preproc} = 0.082\ tCO2/t_{dry\ feedstock}$

A 5.4.3| $PF_{PP,y}$ is the pre-processing emission added to $AEpre - proc, y$ (Equation 12) and hence to the net GHG balance (Section 11). The default $EF_{preproc}$ may be applied in place of metered, facility-specific energy data for the hub where metered data are used instead, pre-processing emissions are determined from the metered electricity and fossil-fuel consumption — electricity at the grid emission factor of Equation 12 and fossil fuel via TOOL 1.

A 5.4.4| Thermal drying carried out at the hub is treated as follows: drying by solar or ambient means, or by heat recovered from the carbonisation process, contributes zero pre-processing emissions; drying fired by grid electricity or fossil fuel is metered and added to $PF_{PP,y}$. The default $EF_{preproc}$ covers mechanical size-reduction and screening only.

A 5.4.5| ***Basis.*** The factor is a conservative size-reduction electricity demand multiplied by a conservative electricity emission factor:

$$EF_{preproc} = E_{size} \times EF_{elec} \times (1 + TDL)$$
$$= 0.050\ MWh/t \times 1.3\ t\ CO_2/MWh \times 1.25 = 0.082\ t\ CO_2e/t$$

ANNEX -6| BIOCHAR PERMANENCE FACTORS (200-YEAR)

A 6.1.1| F_{perm}The permanence factors in Table 24 are the one-sided 95% lower confidence bound of the carbon remaining after 200 years, by molar H:Corg and mean annual soil temperature.

A 6.1.2| Instructions for Use

a|. Identify the molar H:Corg ratio of the biochar batch (Columns).

b|. Identify the Mean Annual Soil Temperature (MAST) of the application site (Rows).

c|. Select the intersecting Permanence Factor (F_{perm}).

d|. For a molar H:Corg ratio between the tabulated columns (for example 0.37), F_{perm}apply the next higher tabulated column.

e|. For temperatures falling between integers (e.g., 23.5^{0}C), F_{perm}round UP to the next whole degree (e.g., 24^{0}C) to ensure conservativeness.

f|. For a MAST below 7^{0}C, apply the 7^{0}C row.

g|. Biochar with a molar H:Corg ratio above 0.50 is not eligible under this pathway; biochar with 0.50 < H:Corg ≤ 0.70 may be credited only under Method 2 (Annex 4; Tracks 2 and 3), and biochar above 0.70 is ineligible.

h|. Biochar with a molar H:Corg ratio below 0.20 is credited at the 0.20 column.

i|. For a MAST above 32^{0}C the tabulated value lies beyond the range of the underlying incubation data and is marked as extrapolated; its use requires activity-specific justification in the PDD or recourse to Method 2.

A 6.1.3| Module A2 / A3 Exemption: Biochar permanently encapsulated in non-porous engineered materials (Module A2) sealed anoxic Dedicated Earth Vaults (Module A3) is physically isolated from biological soil oxidation. Both modules apply the fixed Permanence Factor of 0.95 under Method 3 (Section 8.5). Both modules remain subject to the physical-integrity safeguards in Section 12.

A 6.1.4| Mean Annual Soil Temperature (MAST): MAST is the average soil temperature across all 365 days of the year (encompassing winter and monsoon seasons) and across day/night diurnal cycles, for the 0-30 cm soil layer. While tropical surface soils exposed to direct equatorial sunlight may briefly exceed 35^{0}C, the integrated sub-surface annual mean that governs decadal decomposition is substantially lower.

Table 24. Permanence Factors (F_{perm}) for 200-year durability by molar H:Corg (columns) and MAST (rows); one-sided 95% lower bound

MAST (°C)	0.20	0.25	0.30	0.35	0.40	0.45	0.50	Note
7	0.907	0.901	0.894	0.888	0.881	0.873	0.865	

8	0.894	0.891	0.885	0.876	0.864	0.850	0.833	
9	0.885	0.882	0.876	0.866	0.851	0.831	0.808	
10	0.877	0.875	0.869	0.857	0.839	0.815	0.787	
11	0.870	0.869	0.862	0.849	0.829	0.802	0.770	
12	0.865	0.863	0.856	0.842	0.820	0.790	0.756	
13	0.859	0.858	0.851	0.836	0.812	0.780	0.744	
14	0.855	0.853	0.845	0.830	0.804	0.771	0.733	
15	0.850	0.848	0.841	0.824	0.798	0.763	0.724	
16	0.846	0.844	0.836	0.819	0.792	0.756	0.715	
17	0.842	0.840	0.832	0.814	0.786	0.750	0.708	
18	0.839	0.836	0.828	0.810	0.781	0.744	0.701	
19	0.835	0.833	0.824	0.806	0.777	0.739	0.695	
20	0.832	0.829	0.820	0.802	0.772	0.734	0.689	
21	0.829	0.826	0.817	0.798	0.768	0.729	0.684	
22	0.826	0.823	0.814	0.795	0.764	0.725	0.679	
23	0.823	0.820	0.810	0.791	0.761	0.721	0.675	
24	0.820	0.817	0.807	0.788	0.757	0.717	0.671	
25	0.818	0.814	0.804	0.785	0.754	0.714	0.668	
26	0.815	0.812	0.802	0.782	0.751	0.711	0.664	
27	0.813	0.809	0.799	0.779	0.748	0.708	0.661	
28	0.810	0.806	0.796	0.777	0.746	0.705	0.658	
29	0.808	0.804	0.794	0.774	0.743	0.703	0.656	
30	0.806	0.802	0.791	0.772	0.741	0.700	0.653	
31	0.804	0.799	0.789	0.769	0.738	0.698	0.651	
32	0.801	0.797	0.787	0.767	0.736	0.696	0.649	
33	0.799	0.795	0.785	0.765	0.734	0.694	0.647	extrapolated
34	0.797	0.793	0.782	0.763	0.732	0.692	0.645	extrapolated
35	0.795	0.791	0.780	0.761	0.730	0.690	0.644	extrapolated
36	0.793	0.789	0.778	0.759	0.728	0.688	0.642	extrapolated
37	0.792	0.787	0.776	0.757	0.726	0.687	0.640	extrapolated

38	0.790	0.785	0.774	0.755	0.725	0.685	0.639	extrapolated
39	0.788	0.783	0.773	0.753	0.723	0.684	0.638	extrapolated
40	0.786	0.781	0.771	0.751	0.721	0.682	0.637	extrapolated

ANNEX -7| REVERSAL RISK ASSESSMENT TOOL

A 7.1| Normative Reference:

A 7.1.1| This tool determines the Reversal Risk Rate ($Rate_{risk}$), which sizes the reversal-risk deduction, deposited in the buffer or cancelled at issuance under Section 11.5. It is distinct from the permanence factor of Annex 6 and the removal-uncertainty factor of Section 13.

A 7.2| Applicability:

A 7.2.1| The reversal-risk rate is determined as follows:

a|. Track 1 (distributed) activities, which shall apply the fixed default rate (10%) (Table 25).

b|. For Track 2 (Mechanised) and Track 3 (Industrial) activities, Module A1 (Soil) is assessed by the variable tool in steps 1-4 below, except a Track 2 Module A1 activity settled by cancellation under Section 11.5 (smallholder plots that cannot be monitored individually), which applies the Track 1 rate of Table 14.

c|. Module A2 (Engineered Materials) and Module A3 (Earth vault, subterranean or above -ground) apply the fixed rates in Table 25 and are not assessed by the variable tool.

Table 25. Fixed Reversal Risk Rates (modules not assessed by the variable tool).

Application	Reversal Risk Rate	Basis
Track 1 (Distributed) — Module A1	10.0%	Fixed. Covers diversion and surface loss on dispersed plots that cannot be monitored or assessed site by site; backed by aggregator liability.
Module A2 (Engineered Materials) — Track 2 and Track 3	3.0%	Sealed, non-combustible matrix; residual risk is demolition or accidental building fire. Distinct from the 0.95 permanence factor.
Module A3 (Earth Vault, subterranean or above-ground) — Tracks 2 and 3	2.5%	Sealed, denatured, anoxic vault; no oxidation pathway.

A 7.3| Reversal Risk Tool — Module A1 (Tracks 2 and 3):

A 7.3.1| The Reversal Risk Rate for Module A1 is the computed risk (base risk plus site-specific additions, less verified mitigations), floored at the Track minimum (Table 29):

$$Rate_{buffer} = \max(Floor_{Track,mod,}[R_{base} + \sum R_{Add} - \sum R_{Mit})$$

Parameter	Description
R_{base}	Step – 1 base risk (Table 26) Score determined by the end-use module.
R_{Add}	Step - 2 risk (Table 27) additions based on site-specific hazards.
R_{Mit}	Step -3 sum of verified risk mitigations (Table 28). Evidence for every addition and mitigation shall be provided in the PDD.
$Floor_{Track,mod,}$	The minimum allowable rate for biochar is 2.5%, unless a higher rate is required by this methodology.

A 7.3.2| Step 1: Determine Base Risk (R_{base}):

Table 26. Base Risk by End-Use Module (Module A1).

Module	Base Risk	Primary Risk Driver	Justification
A1: Soil	7.5%	Open system; surface erosion, fire, biotic disturbance.	Aligns with baseline Land Use & Forestry (LUF) non-permanence risk thresholds for open agricultural systems. Set below the 20% Gold Standard default for soil-organic-carbon activities to reflect biochar's superior physical recalcitrance, while capitalising the reserve against surface loss by runoff, fire and disturbance. The base assumes incorporation; surface application without incorporation carries the addition of Table 27.

A 7.3.3| Step 2: Risk Additions (R_{Add}): Add the percentages below if the criteria are met. Evidence shall be provided in the PDD. Where a criterion cannot be evidenced, the addition applies.

Table 27. Site-specific Risk Additions

Category	Risk Factor	Criteria	Add	Evidence Required
Natural	Fire Exposure *(Modules A1)*	Site in "High Fire Risk" zone (Fire return interval <30 yrs).	+ 4.0%	National Fire Map / NASA FIRMS
		Site in "Moderate Fire Risk" zone (FRI 30–100 yrs).	+ 2.0%	
Social	Diversion	Local Charcoal Price exceeds biochar production cost.	+ 5.0%	Local Market Survey

Legal	Land Tenure	Lease shorter than the crediting period and without a right of renewal.	+ 1.5%	Lease Agreement/ Title deed
	Enforcement	No legal covenant recording carbon storage on deed.	+ 1.0%	Legal opinion or Registry Search.
	Surface application	Biochar applied without incorporation (no-till or broad-acre surface application, Annex 3).	+ 2.0%	Application records; field audit

A 7.3.4| Step 3: Apply Mitigation Discounts (R_{Mit})**:** Subtract these percentages if the safeguard is verified.

Table 28. Verified Mitigation Discounts

Safeguard	Criteria	Deduct	Evidence Required	Scientific Justification
Deep Incorporation (stricter than the 10 cm incorporation of Table 15)	Biochar injected >20 cm depth (Module A1).	- 2.5%	Field Audit / SOPs	Removes the surface-runoff loss pathway, the only quantified physical loss mechanism for soil biochar.
Irrigation	Site is permanently irrigated.	- 2.0%	Irrigation Plan	Water saturation limits oxygen availability, reducing decay.
Denaturing (offset)*	Biochar mixed with manure/compost (Non-combustible).	- 4.0%	Product Formulation Log	Offsets the Diversion addition only — see note below.
Ownership	Land Owned by activity developer (Freehold).	- 1.0%	Title Deed	Removes tenure risk.
Insurance	Valid Policy covering reversal events.	- 2.5%	Insurance Certificate	Transfers financial liability.

Denaturing offset. The Denaturing discount applies solely against the Diversion addition (Table 27) and may not exceed it: the net diversion contribution is MAX(0, Diversion − 4.0%).

Where the Diversion addition is not triggered, Denaturing confers no discount. This prevents a mitigation from reducing the reserve below the residual risk that is actually present.

A 7.3.5| Step 4: Minimum Floors $(Floor_{Track,mod})$

Table 29. Minimum Floors for Module A1.

Compliance Track	Module A1 (Soil)
Track 2 (Mechanised)	2.5%
Track 3 (Industrial)	2.5%

A 1.1| Buffer Draw-down on Reversal

A 7.3.6| The buffer is drawn down for verified unavoidable reversals on Track 2 and Track 3 monitorable sinks in accordance with Section 12.5 (Equation 30); one buffer credit is cancelled per tonne reversed. For Track 1, a Sentinel breach above 5.0% of sampled sites triggers the aggregator liability protocol of Section 12.5. An unrepaired containment breach beyond 30 days is an Avoidable Reversal (Section 12.4), and cessation of monitoring of a monitorable sink is an Avoidable Reversal (Section 16.1). The reversal-risk deduction itself is applied once, at Equation 27 (Section 11.5). https://doi.org/10.1021/es903140c

ANNEX -8| BIOMASS SURPLUS & SUSTAINABILITY REQUIREMENTS

A 8.1| Scope, status and supersession

A 8.1.1| This Annex establishes the mandatory requirements governing the eligibility, surplus status, sustainable sourcing and chain of custody of biomass feedstock used by mitigation activities under this methodology. It applies to all Feedstock Modules (F1–F6) and all Compliance Tracks, except where a provision is expressly restricted to a specific Module or Track.

A 8.1.2| Where any provision of the methodology body refers to the "Biomass Sustainability Requirements", a "Surplus Test", "sustainable extraction rates", or a "GS4GG Biomass Tool", those references shall be read as references to this Annex.

A 8.1.3| **Supersession and migration:** This Annex remains in force unless and until superseded, in whole or in part, by a published GS4GG programme-level Biomass Sustainability Requirement or an equivalent Article 6.4 / PACM standard document approved by GS4GG, upon which the published standard shall prevail to the extent of any inconsistency. References to CDM methodological tools within this Annex are valid until equivalent GS4GG or A6.4 / PACM tools are published.

A 8.1.4| **Conservativeness rule:** Where the surplus status, alternative fate or sustainability of a feedstock cannot be demonstrated to the standard of this Annex, the feedstock is ineligible, or — where the methodology provides a quantified deduction for the relevant effect — that conservative deduction shall be applied. The activity developer shall not resolve uncertainty in favour of higher crediting.

A 8.2| Feedstock-eligibility framework

A 8.2.1| Eligible feedstock is restricted to the Feedstock Modules defined in Annex 1 (F1–F6), subject to the Module-specific Compliance-Track restrictions in the methodology body and to the conditions of this Annex. The Feedstock Modules are distinct from the additionality Positive List of Section 6.

A 8.2.2| **Evidentiary tiering:** Each feedstock is assigned to an evidentiary tier governing the depth of demonstration required:

a|. Tier I (lower risk): F2 (processing residues at a controlled facility); F3 (restorative / Invasive Alien Species biomass).

b|. Tier II (standard): F1 (field residues); F4 (disaster and sanitary).

c|. Tier III (higher risk): F5 (purpose-grown); F6 (organic waste). Tier III feedstock is admitted only under Track 3 and is subject to the full requirements of A8.3–A8.9.

A 8.2.3| **Exclusions — all Modules and Tracks**: The following are ineligible:

a|. biomass whose harvest or removal causes the conversion or degradation of a natural ecosystem (see A8.6);

b|. food- and feed-grade biomass, and biomass diverted from existing food or feed use;

c|. high-value roundwood, saw logs, veneer logs and industrial-grade roundwood, and stumps and roots;

d|. biomass with a viable existing or reasonably foreseeable material use, or any use that would retain the biogenic carbon in durable storage for a period equal to or exceeding the durable storage credited under this methodology (cascading principle; see A8.3, A8.4);

e|. biomass from dedicated plantations established on wetlands or organic soils;

f|. commingled waste that has not undergone verified source separation (F6).

A 8.2.4| Cascading principle: Biomass shall be directed to its highest-value use. Where a viable material use, or a use that would retain the biogenic carbon for longer than the durable storage credited under this methodology, exists for the feedstock, the biomass is ineligible for pyrolysis under this methodology.

A 8.3| Alternative-fate determination

A 8.3.1| The crediting baseline for the pyrogenic carbon is zero (BR_{unadj}= 0; Section 7.3 |). Eligibility under this Annex requires that, absent the activity, the biogenic carbon in the feedstock would be returned to the atmosphere within ten years and would not form durable pyrogenic carbon.

A 8.3.2| Decay test: For each feedstock, the activity developer shall determine the realistic alternative fate of the biomass absent the activity, and shall demonstrate that, under that fate, the biogenic carbon would be substantially returned to the atmosphere within ten years.

A 8.3.3| Longer-storage exclusion: Where the realistic alternative fate would retain the biogenic carbon in durable storage for a period equal to or exceeding ten years - including standing biomass, slow-decay woody debris retained in situ, durable wood products, or stable incorporation into soil organic carbon - the feedstock is ineligible. The realistic decay horizon shall be determined by reference to the feedstock decay-class reference (Table 30); feedstock assigned to a durable class is ineligible.

A 8.3.4| Deemed compliance: Field residues comprising the herbaceous or fine fraction (for example, straw, stover, husks, leaves and fine prunings) are deemed to satisfy A8.3.2 without further demonstration. Woody fractions, and all Tier III feedstock, require explicit demonstration.

A 8.3.5| Organic waste, F6: For Module F6, the alternative fate shall be determined conservatively by reference to the actual prevailing management of the waste stream (for example, controlled composting, anaerobic digestion, managed landfill with gas capture, or existing material or feed use). A feedstock whose biogenic carbon would, under the prevailing alternative fate, have been retained in durable storage is ineligible. The methodology credits only the durable pyrogenic carbon; it does not credit avoided

methane or other avoided emissions from the counterfactual fate, and no such avoided emission shall be claimed.

Table 30. Feedstock decay-class reference:

Class	Feedstock	Indicative decay horizon	Treatment
A	Fine herbaceous residues (straw, stover, husks, leaves, fine prunings)	< 2–3 yr	Deemed eligible (no demonstration)
B	Coarse herbaceous / fibrous processing residues (bagasse, shells, fibre)	< 5 yr	Eligible
C	Small-diameter woody debris (branches, twigs, slash of diameter below 10 cm)	Variable; commonly < 10 yr in warm/humid, longer in cold/dry	Eligible with climate-specific demonstration
D	Large-diameter woody debris / logs of diameter 10 cm and above	Commonly ≥ 10 yr	Presumptively durable → ineligible unless site evidence shows < 10 yr
E	Sawlog/veneer-grade roundwood, mill-bound timber, durable-product-destined wood	Durable	Ineligible (also excluded under cascading, A8.2.3)

A 8.4| Surplus and dynamic-availability test

A 8.4.1| Requirement: The activity developer shall demonstrate, prior to design certification and at each Crediting Period Renewal, that the biomass feedstock is surplus. Surplus is established by the marginal consequence of diverting the biomass to the activity, and not by its classification as "waste".

A 8.4.2| Existing-use screen: The activity developer shall demonstrate that, at the point of sourcing, the feedstock is not committed to, or in active use for, a competing application[3] - including thermal energy, animal fodder or bedding, controlled composting, field mulching or soil return, or any material use. Where the competing use is an energy, fodder, bedding, composting or soil-return use, the feedstock fails the Surplus Test and either the market-leakage deduction of body Section 10.5 (Table 12) shall be quantified or the feedstock shall be excluded; where the competing use is a material use, the feedstock is ineligible (A8.2.3, A8.2.4). Acceptable

[3] Acceptable evidence of no competing use is defined: A documented local biomass-use survey, generator/supplier declarations, and — where a market exists — prevailing market-price evidence, a positive price being prima facie evidence of a competing use.

evidence of the absence of a competing use comprises a documented local biomass-use survey, generator or supplier declarations, and - where a market exists for the feedstock - evidence of its prevailing market price; a positive market price is prima facie evidence of a competing use.

A 8.4.3| **Supply shed**: The activity developer shall define the supply shed in the PDD - the economically viable collection area for the feedstock, or, where appropriate, an administrative region - and fix it for the crediting period.

A 8.4.4| **Surplus quantification and headroom test**: The activity developer shall quantify the verifiable surplus of the supply shed using published residue-availability data (national agricultural or forestry statistics, recognised spatial residue assessments, or equivalent), published residue-to-product ratios (for example IPCC 2019 or national statistics) and documented existing-use fractions; where no applicable dataset exists, a primary survey to a documented standard shall be undertaken. The activity developer shall maintain a demand register cataloguing operating and publicly announced biomass-consuming installations within the supply shed - for energy, fuels, materials and other carbon-crediting activities - and their nameplate demand. The activity is eligible only where its aggregate demand, together with (for a Programme of Activities) that of all overlapping VPAs (body Section 17), plus existing committed use and registered announced demand, does not exceed the assessed surplus, retaining a conservative buffer. Where this headroom test is not satisfied, the feedstock fails the Surplus Test.

A 8.4.5| **No manufactured supply**: The activity shall demonstrate that the revenue from carbon crediting does not create an incentive to generate additional waste, to increase harvest, or to bring non-surplus biomass into use.

A 8.4.6| **Re-assessment**: The Surplus Test shall be repeated prior to each Crediting Period Renewal. A feedstock that ceases to be surplus shall be excluded from that point, or the market-leakage deduction applied from that point.

A 8.5| Sustainable extraction rates:

A 8.5.1| **Requirement:** For Module F1 (field residues), the activity developer shall not remove residue below the retention floor necessary to maintain soil organic carbon, soil cover and nutrient balance, and to control erosion.

A 8.5.2| **Default floor**: Absent a site-specific determination, not less than 70% of the field residue, by dry mass, shall be retained on the field.

A 8.5.3| **Soil- and slope-sensitive override:** The retention floor shall be increased above the default where soil texture, slope or erosion risk warrant — in particular on sloping or erosion-prone land and on coarse-textured tropical soils. On land with a slope above 8 per cent, on sandy or coarse-textured soils, or where the national soil authority classifies the field as erosion-prone, the default floor does not apply and the retention rate shall be set by a site-specific agronomic assessment — the national extension recommendation for the crop and soil, or a determination by a qualified agronomist — and shall in every case be at least 70 per cent. A floor lower than the default is not permitted.

A 8.5.4| Interaction with ecological leakage: Residue removed within the retention floor remains subject to the ecological-leakage deduction of body Section 10.6 (foregone soil organic carbon and N-P-K replacement).

A 8.6| Sustainability sourcing criteria and safeguards:

A 8.6.1| No-go areas; no conversion: Biomass shall not be sourced from, and no land shall be converted from: primary or old-growth forest; other naturally regenerating forest of high biodiversity value; natural grassland; wetland or peatland; or other land of high carbon stock or high biodiversity value. Land converted from any such category after 31 December 2020, the fixed reference date of Annex 1 and Section 10.2, is ineligible.

A 8.6.2| Sustainable harvest: Where biomass is sourced from managed forest or rangeland, harvest shall be legal; shall not exceed the rate of regeneration; shall safeguard protected areas; and shall maintain soil quality and biodiversity. Conversion of forest to plantation is prohibited, and clear-cutting shall be minimised.

A 8.6.3| Food, water and social safeguards: Sourcing shall not compromise local food or feed security; shall not cause unsustainable water abstraction; and shall respect land tenure and the rights of local communities and Indigenous Peoples.

A 8.6.4| Recognised schemes: Demonstrated compliance with the applicable criteria of a recognised sustainability or chain-of-custody scheme (for example, the EU RED III sustainability criteria, ISCC, FSC, PEFC, or SBP), or with the European Biochar Certificate feedstock positive list, may be relied upon as evidence of conformity with the corresponding requirements of this section. Such reliance does not displace the surplus and counterfactual requirements of A8.3–A8.4.

A 8.6.5| Contamination routing — cross-reference: Contaminant thresholds and end-use routing for treated or contaminated streams are governed by Annex 1. Biomass failing those thresholds shall be routed to non-soil end-uses (Modules A2 / A3) and shall not be applied to soil.

A 8.7| Leakage inputs

A 8.7.1| Market leakage: Where a feedstock fails the Surplus Test (A8.4), market-leakage emissions shall be quantified in accordance with Methodology Section 10.5 using the Default Replacement Factors of Table 12.

A 8.7.2| Ecological-leakage default factors: The default factors for ecological-leakage quantification under body Section 10.6 (Equation 23a) — the nitrogen, phosphorus and potassium replacement emission factors and the foregone soil-organic-carbon factor — are set out in Table 31, and the default nutrient contents of field residues for Track 1 and Track 2 in Table 31a. Track 3 activities measure the nutrient content of the exported residue.

Table 31. Ecological-leakage default factors

Parameter	Symbol	Unit	Default	Basis
Nitrogen replacement EF	EF_N	$tCO_2e/t\ N$	12.1	Full-chain intensity of synthetic nitrogen (production, transport and field N_2O); set above the global mean (Menegat et al., 2022)
Phosphorus (P_2O_5) replacement EF	EF_P	$tCO_2e\ /t\ P_2O_5$	1.5	Phosphate fertiliser production; above the European Commission (2015) standard value of 1.01
Potassium (K_2O) replacement EF	EF_K	$tCO_2e/t\ K_2O$	0.6	Potash production; European Commission (2015) standard value of 0.58, rounded up
Foregone soil-organic-carbon penalty	F_{SOC}	tCO_2e/t residue	0.19	Regional short-term SOC accumulation foregone on removal (conservative)

Table 31a. Default nutrient contents of field residues (Tracks 1 and 2), t per t dry residue

Residue class	N	P_2O_5	K_2O	Basis
Cereal straw and stover (maize, wheat, rice, sorghum, millet)	0.008	0.003	0.015	Upper range of residue compositions (IPCC, 2019, Vol. 4, Ch. 11, Table 11.1A; Smil, 1999)
Other herbaceous residues (legume haulms, cane trash, grasses)	0.012	0.003	0.015	Upper range (Smil, 1999)
Woody prunings and orchard residues	0.005	0.001	0.004	Upper range (Smil, 1999)

A 8.7.3| Activity-shift / iLUC leakage, F5: Activity-shift leakage for Module F5 is governed by body Section 10.7 and A8.8.2: it is zero where the land condition of A8.8.2 is met, and the feedstock is otherwise ineligible. Cultivation emissions, including direct soil-organic-carbon change, are activity emissions under A8.8.3. No indirect land-use-change estimate is quantified.

A 8.7.4| Soil disturbance ($AE_{SOC\text{-}loss}$, Section 9.6): where biochar is incorporated by tillage deeper than 30 cm on land under verifiable no-till agriculture or perennial grassland, the loss of soil organic carbon caused by the tillage shall be estimated with the stock-change method and the tillage factors of the 2019 Refinement to the 2006 IPCC Guidelines, Volume 4, Chapter 5, over the crediting period, and charged as an application emission under Equation 19. In all other cases $AE_{SOC\text{-}loss} = 0$. The foregone-soil-carbon leakage factor of Table 31 is a separate quantity and is not charged twice.

A 8.8| Module-specific provisions

Module F5 (Purpose-Grown)

A 8.8.1| F5 is restricted to Track 3 and to biomass cultivated on confirmed degraded, marginal or contaminated land. F5 biomass shall not be a food or feed crop, and cultivation shall not displace food or feed production.

A 8.8.2| **Land condition:** Activity-shift leakage is deemed zero ($LE_{shift,y} = 0$) only where the activity developer demonstrates, by remote sensing and supporting evidence, all of the following:

a|. the cultivation land was degraded or marginal and was not in productive agriculture or grazing use on or after 31 December 2020 (the fixed-date test of Annex 1);

b|. the land was not cleared or converted from a natural ecosystem (A8.6.1); and

c|. the land was not diverted from food or feed production. Where any criterion is not met, the feedstock is ineligible (body Section 10.7).

A 8.8.3| **Cultivation emissions**: Full lifecycle cultivation emissions — N_2O from fertiliser, CO_2 from machinery, and direct soil-organic-carbon change — shall be quantified using CDM TOOL16 (or the equivalent published PACM tool) and included as activity emissions. N_2O from fertiliser shall not be omitted.

A 8.8.4| **Net-carbon-negative test**: Where the land condition of A8.8.2 is met, indirect land-use-change leakage is deemed zero and the net-carbon-negative test is assessed on direct emissions only; where it is not met, the feedstock is ineligible, and no bespoke indirect-land-use-change estimate is required or accepted. The activity shall demonstrate, on a cradle-to-grave basis incorporating the cultivation emissions of A8.8.3 (and any applicable direct land-use-change emissions), that the Module F5 pathway yields a net carbon removal against a credible baseline. Where it does not, the F5 feedstock is ineligible.

Module F6 (Organic Waste)

A 8.8.5| F6 is restricted to Track 3 facilities with advanced sorting and emissions filtration.

A 8.8.6| **Source separation and biogenic fraction:** Source separation shall occur at the point of generation or through a verified materials-recovery process before pyrolysis; commingled waste that has not undergone verified source separation is ineligible. The biogenic carbon fraction shall be substantiated

by radiocarbon (^{14}C) testing in accordance with the body Radiocarbon Monitoring provision. Only the verified biogenic fraction is creditable; the fossil fraction and its corresponding CO_2 are fully accounted and are ineligible.

A 8.8.7| Alternative fate: The alternative fate of F6 biomass shall be determined under A8.3.5; a feedstock whose biogenic carbon would have been retained in durable storage under the prevailing alternative fate is ineligible.

A 8.9| Traceability and chain of custody

A 8.9.1| Requirement: The activity developer shall maintain a documented, auditable chain of custody from the point of biomass origin to pyrolysis, proportionate to the feedstock's evidentiary tier (A8.2.2).

A 8.9.2| Minimum evidence by tier

a|. **All tiers:** feedstock type and quantity; geo-referenced point of origin (collection zone or land parcel); Surplus-Test justification (A8.4).

b|. **Tiers II and III, and Module F2, additionally**: Letter of Origin from the generator or processing facility; weighbridge or equivalent mass records.

c|. **Tier III, additionally:** parcel-level land-classification and remote-sensing evidence (F5, per A8.8.2); source-separation and ^{14}C records (F6, per A8.8.6).

A 8.9.3| Mass-balance reconciliation: Feedstock records shall reconcile with the biochar mass balance (Section 8; Annex 5 maximum-yield flag). A material discrepancy triggers exclusion of the affected volume.

A 8.9.4| Retention: Records shall be retained in in accordance with the record-retention requirements of Section 15.1.3.2 | and the GS4GG Principles and Requirements.

ANNEX -9| REFERENCES

A 9.1| Standards and regulations

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A 9.2| Scientific Literature

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