Gold Standard for the Global Goals

METHODOLOGY

GS4GG PAA M400-14

SDG 13

GRID-CONNECTED RENEWABLES, STORAGE, & ENERGY TRANSITION (G-RESET)

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SUMMARY

This methodology provides a framework for quantifying greenhouse gas (GHG) emission reductions attributable to activities focused on grid-connected renewable energy generation, brownfield asset optimisation, energy storage (temporal arbitrage) and captive renewable supply, including behind-the-meter, wheeled and dedicated-line delivery to a captive or contracted consumer - and the aggregation of distributed energy resources into virtual power plants (VPPs).

Conventional electricity systems rely heavily on dispatchable fossil-fuel generation to meet baseload demand and manage peak load variability, resulting in significant carbon dioxide (CO_2) emissions.

The Grid-connected Renewables, Storage, & Energy Transition (G-RESET) methodology provides a modular architecture to displace GHG-intensive grid or captive electricity and shift low-carbon electricity in time to displace higher-carbon marginal generation.

This methodology shall be used in conjunction with the GS4GG GHG Emissions Reductions & Sequestration Product Requirements and activities and programmes applying this methodology may be issued with GSVERs.

Key methodological components:

- **Modular architecture:** The methodology applies to activities deploying one, or a combination, of five modules: Greenfield Generation (Module GG), Brownfield & Asset Optimisation (Module BO), Energy Storage & Time-shifting (Module ST), Captive Generation (Module CG) and Virtual Power Plants (Module VPP).

Modules may be applied independently or stacked as an Integrated Solution. A module or capacity added after validation is registered as a new co-located activity or proceeds as a design change (Sections 3.5, 6.7 and 16). Two further functions - Grid Stability & Ancillary Services and Demand-side Flexibility - are reserved for future revisions and are not available under Version 1.0.

- **Life-cycle integrity:** The methodology accounts for the full life cycle of the infrastructure: it enforces embodied (life-cycle) emission deductions for material-intensive hardware, mandates End-of-Life (EoL) Decommissioning Plans for utility-scale assets, and requires digital Measurement, Reporting and Verification (dMRV) at tiered accuracy, revenue-grade for metering points above 5 MW or 5 MWh (Section 14).
- **Baseline**: The crediting baseline is determined through the five-step procedure of the GS4GG Requirements for Baseline Determination (PAA MS400-04), applying the baseline approaches of paragraph 36 of the Article 6.4 Rules, Modalities and Procedures via an existing-actual-or-historical-emissions approach, adjusted downwards, in accordance with the GS4GG Requirements for methodology development.
- **Ambition:** To increase mitigation ambition over time and align with national decarbonisation pathways, the baseline is adjusted downwards using a Downward Adjustment Factor (DAF) determined under the GS4GG PAA Methodology Tool MT400-05.
- **Anchoring and reach**: Additionality and quantification are anchored to the UNFCCC Article 6.4 mechanism methodological tools A6.4-AMT-002; A6.4-AMT-006; with the GS4GG Technical Addendum to the A6.4 technical lifetime of equipment; and A6.4-AMT-007 read with the GS4GG Technical addendum to the A6.4 Grid Emission Factor Tool. The methodology imposes no location-based eligibility restriction, provides an explicit transition pathway for activities migrating from the CDM methodologies (ACM0002, AM0123, AMS-I.D and AMS-I.F) and earlier GS4GG versions, and is designed to be applied in combination with Accompanying Methodologies where an installation delivers mitigation outcomes beyond power generation.

ACKNOWLEDGEMENT

This methodology was developed by Gold Standard, in collaboration with APh ePower Co., Ltd. (developer of ESS methodology, incorporated into Module ST). Gold Standard would like to thank our experts for their valuable feedback during the review process.

VERSION **1.0**
SCOPE **01 Energy industries**
MITIGATION **Emission reduction**

G-RESET Grid-connected Renewables, Storage & Energy Transition

Crediting the displacement of grid or captive fossil electricity, and the shifting of low-carbon electricity in time, through five modules applied alone or stacked as an Integrated Solution.

MITIGATION TYPE
Avoided fossil CO_2
From the grid or captive fossil assets, including avoidance through temporal shifting. Reductions only; no removals.

ACTIVITY SCALE
Micro · Small · Large
Micro ≤ 10,000 tCO_2e per year; small up to 15 MW; large above. Measured per module in MWac.

CREDITING PERIOD
5 years, renewable twice (15)
Within the technical lifetime of the assets, or the remaining useful life of the displaced asset under BO.

GEOGRAPHY · GWP
Global · IPCC AR5, 100-year
No location-based restriction. Eligibility rests on additionality. Transition path from ACM0002, AM0123, AMS-I.D, AMS-I.F.

ACTIVITY MODULES Selected by the physical function of the intervention, on top of the Universal Core — S.3.1 · 3.2.2

GG
Greenfield generation
New renewable plants at a site with no prior plant of the same technology: solar, wind, hydro, geothermal, marine, and the power component of biomass, biogas, LFG and WHR.
`Combined margin`

BO
Brownfield & asset optimisation
Capacity additions, retrofits, rehabilitation, replacement and repowering. Only incremental generation above a Declining Baseline is credited.
`RUL ≥ 5 years`

ST
Storage & time-shifting
Storage of any medium, standalone or integrated: BESS, pumped hydro, thermal, flow, mechanical. Credits the carbon difference between charging and discharging.
`Tiered operating margin`

CG
Captive generation
Renewable supply to a captive or contracted consumer behind the meter, by wheeling or open access, or by dedicated line. Delivery must be physical.
`MIN(captive, grid)`

VPP
Virtual power plants
Aggregated distributed energy resources within a Digital Aggregation Perimeter. Additionality, common practice and scale are assessed at platform level.
`GG + ST engines`

INTEGRATED SOLUTION modules stacked at one site, each with its own baseline and additionality · electricity routed internally credited once, under ST

FOUR SCALE THRESHOLDS Each governs a distinct requirement, assessed on the Activity Cluster where it applies — TABLE 1 · 5.3.5

≤ 10,000 t/yr
Micro-scale
Opens the Positive List route to additionality (S.6.2, Annex 6).

≤ 5 MW · LDC, SIDS
Common-practice exemption
All modules together; DC rating for solar PV (S.6.6).

> 5 MW · > 5 MWh
Utility-scale
End-of-Life Plan per activity; revenue-grade metering per metering point.

> 15 MW hydro
Large-scale hydropower
Independent Hydropower Sustainability Standard assessment.

RESERVED FOR FUTURE VERSIONS Grid stability and ancillary services; demand-side flexibility. Not eligible under Version 1.0.

HYDROPOWER POWER DENSITY · GG, BO, ST · S.3.2.4

≤ 4 W/m²	4 – 10 W/m²	> 10 W/m²
New or expanded reservoir ineligible	Default reservoir factor deducted (Eq. 30)	No reservoir emissions

Run-of-river: impoundment up to 24 hours at design flow. Any reservoir plant, and any plant above 15 MW, is assessed against the Hydropower Sustainability Standard. Expansions use incremental power density.

FOSSIL-FUEL CONDITIONS · EACH CALENDAR MONTH · S.8.3

≤ 5%	Traced	100 h
Fossil share of monthly generation (Eq. 23–24)	All fuel tied to ignition, start-up or backup	Backup hours per year, outages excluded

A failing month is non-conforming: its generation counts as zero while activity emissions and leakage are deducted in full. Other months and eligibility are unaffected.

CORE APPLICABILITY · ALL MODULES · S.3.2

EQUIPMENT	All primary generation and storage equipment newly manufactured; replaced units decommissioned, or resale disclosed.
DATA VINTAGE	Historical generation for BO no older than three years before PDD submission.
TELEMETRY	ST, CG and VPP need automated digital metering; Tier 2 hourly factors where the system operator publishes them.
END OF LIFE	Utility-scale hardware has a decommissioning plan, progressively capitalised. VPPs meet it through take-back schemes.
ATTRIBUTES	RECs, I-RECs and guarantees of origin cancelled; no Scope 2 claim by the offtaker for the same MWh.
COMBUSTION	Power component only; other outcomes under an Accompanying Methodology (Annex 5). No high-carbon-stock feedstock.

INELIGIBLE ACTIVITIES · S.3.2.3

- Continuous fossil co-firing
- Fossil-to-renewable switch at the site (GG, BO)
- Un-electrified or suppressed-demand baselines
- T&D loss reduction
- GHG removals
- Virtual or financial PPA under CG (assessed as GG)

MODULE CONDITIONS

BO	Existing asset needs a certified remaining useful life of at least 5 years; below that the baseline is zero.
ST	Zero charging factor only for evidenced would-be-curtailed or DC-coupled co-located charging (Annex 2).
CG	No prior renewable supply; contracted for the crediting period; exports under GG.
GEO	Passes the emission-intensity screen of Annex 6; fugitive gases counted as activity emissions.
MARINE	Independent EIA on habitats and migration; End-of-Life Plan for submerged infrastructure.

COMMON PRACTICE · MT400-06 · S.6.6

Stock-based, per module

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

F ≥ 10% → not additional

Installed capacity in the host country or sub-national grid, by technology class and supply configuration (grid, captive, VPP). Credited and majority grant-funded capacity excluded from P_{sim}. One module failing leaves the others eligible.

ADDITIONALITY · SECTION 6 · EACH MODULE

Regulatory surplus
Not mandated; binding auction delivery obligations fail.

Lock-in · MT400-09
Quantitative only for combustion and reservoir hydro.

Investment · AMT-002
Real terms; mature solar and wind checked against recent auction prices.

Micro-scale route
Positive List replaces investment and common practice tests.

Each module assessed with the others present. At renewal: regulatory surplus, ongoing financial need and common practice.

NET EMISSION REDUCTIONS · EQ. 41

$$ER_y = ER_{GEN} + ER_{ST} - AE_{FIRE} - AE_{RES,PHS}$$

$ER_{GEN} = BE_{crd} - AE_{GEN} - LE$ · deficits carried forward

CREDITING BASELINE · EQ. 14–19

$BE_{crd} = MIN(BE_{unc} \times (1-DAF), BAU) \times CF$

$\Delta = BAU - BE_{crd}$, reported

BE_{unc} sums GG, BO, CG and VPP generation; storage settles in ER_{ST}. CF = 1.

BE Baseline by module

SECTION 7

Approach (c), existing actual or historical emissions, adjusted downwards; five steps of MS400-04 per module.

GG	Net creditable export × combined margin, Eq. 1–2
BO	Output above a Declining Baseline × combined margin; zero once RUL ends, Eq. 3–6
ST	Net discharge × interval operating margin; Tier 1 × 0.90, Eq. 7
CG	Supply × MIN(captive fossil, grid); captive factor alone if no grid, Eq. 8–10
VPP	Net-new generation on the GG engine plus storage on the ST engine, Eq. 11–13

DECLINING BASELINE · BO

Mean of the last three normalised years, plus 6% uplift, minus 0.5% per year degradation for PV and onshore wind. Offshore needs site data.

AE Activity emissions

SECTION 8

$AE = FF+GEO+RES+AUX+CHG+FIRE$ · Eq. 20

FF	Fossil fuel for ignition, start-up, backup and O&M, Eq. 21–22
GEO	Non-condensable gases, all assumed vented, and binary working fluid, Eq. 25–28
RES	Reservoir CH_4 where 4 < PD ≤ 10 W/m², Eq. 29–30
AUX	Auxiliary grid import at the upper-bound factor, unless netted, Eq. 31
CHG	Grid charging and PHS pumping, metered gross; settled inside ER_{ST}, Eq. 32
FIRE	BESS suppression agents with GWP > 1; zero for low-GWP agents, Eq. 33

Biogenic CO_2 and methane destruction belong to the Accompanying Methodology. Fuel with missing records is treated as co-firing.

LE Leakage

SECTION 9

$LE = EMB + WAKE + LUC$ · Eq. 34

EMB	Embodied hardware emissions over N = MIN(lifetime, 15 years), or in full at first issuance, Eq. 35–37
WAKE	Yield lost by third-party arrays within 5 km onshore or 100 km offshore, modelled loss +50%, Eq. 38
LUC	Carbon-stock loss over five IPCC pools, amortised over 20 years, Eq. 39–40

EMBODIED DEFAULTS · ANNEX 1

PV c-Si 1,000 t/MWp · ballast 1,750
LFP 99 t/MWh · NMC 145 t/MWh

Unrecovered embodied and land-use balance trued up at the final issuance if crediting stops early (Eq. 40a). Equipment transfer resolves to zero.

STORAGE RECONCILIATION · EQ. 43 · ANNEX 2

$ER_{ST} = MAX(0, \Sigma_h EG_{dis,h} \times [EF_{OM,h}(1-DAF) - EF_{pool,h} / RTE])$

Rolling energy-weighted carbon pool. Floor applies to the monitoring-period total, so carbon-blind cycles offset beneficial ones.

MONITORING · DMRV · 5.14

Hourly meters · ≥ 95% complete

Gaps: export zero, import at maximum. VPP aggregation waiver: class 1–2 telemetry, 3% discount, settlement check.

UNCERTAINTY · 5.13

Conservative parameter bounds

Grid factors at the AMT-007 lower bound for baseline, upper bound for activity. No reversal risk.

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1| KEY INFORMATION

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

Table 1. Key information

Term	Description
Activity summary	The mitigation activity involves grid-connected renewable energy generation, brownfield asset optimisation, energy storage (temporal arbitrage), and behind-the-meter or contracted captive supply (including corporate PPAs and wheeling), and the aggregation of distributed energy resources into virtual power plants (VPPs). Using a modular, plug-and-play architecture, the activity displaces GHG-intensive grid or captive electricity and shifts low-carbon electricity in time to displace higher-carbon marginal generation.
Mitigation type	☒ **Emission reductions** Avoidance of fossil-fuel derived carbon dioxide (CO_2) from the electricity grid or captive fossil-fuel assets, including avoidance achieved through the temporal shifting of low-carbon electricity.
Applicable activity scale	☒ Micro scale (≤10,000 tCO_2e per year) ☒ Small scale (≤ 15MW) ☒ Large scale (>15MW) **Scale is measured by module:** • For generation (Modules GG and BO), the installed/rated generation capacity on an alternating-current basis (nameplate AC, at the point of connection); • For storage (Module ST), the maximum rated discharge power of the power-conditioning system/inverters (MWac); • For captive activities (Module CG), the installed renewable capacity supplying the captive load; and for VPPs (Module VPP) and PoAs, the aggregate installed power capacity of all participating distributed energy resources (DERs) within the activity/VPA boundary, not the individual-asset level. • The micro-scale ≤ 10,000 tCO_2e/yr emission threshold applies across all modules. Four scale thresholds apply, each to a distinct purpose, and each is assessed on the Activity Cluster where Section 3.5 applies: i. micro-scale (≤ 10,000 tCO_2e/yr) governs the additionality route (Section 6.2, Annex 6); ii. installed capacity of up to 5 MW in a Least Developed Country or Small Island Developing State (for solar PV,

	the DC rating) governs the exemption from the common-practice analysis (Section 6.6); iii. utility-scale (> 5 MW generation or > 5 MWh storage) governs the End-of-Life Plan, per activity, and the revenue-grade metering architecture, per metering point (Section 14). It is independent of the small-scale and large-scale classification, so an activity of 5 to 15 MW is small-scale but utility-scale for these two purposes; and iv. large-scale hydropower (> 15 MW) governs the Hydropower Sustainability Standard assessment (Section 3.2).
Sectoral Scope	**01:** Energy industries (renewable/non-renewable sources)
Activity Requirement	Energy Systems and Efficiency (ESE)
Activity start date	The date on which the activity developer commits to major financial expenditure for the implementation, procurement or construction of the core activity equipment, that is, the earlier of an irreversible commitment to equipment procurement or construction, or cumulative committed expenditure reaching a material fraction of 5% of the total expected activity cost.
Crediting Period start date	The date of commercial operation (start of use) of the first unit or module, or a maximum of two years prior to the date of Design Certification, whichever occurs later.
Crediting period length	Five years, renewable twice (a maximum of 15 years in total), subject at each renewal to a reassessment of regulatory surplus, ongoing financial need and common practice. Emission reductions are issued only for the period in which the relevant assets remain within their technical lifetime, as determined under A6.4-AMT-006, read with the GS4GG technical lifetime addendum, or the remaining useful life (RUL) of the displaced baseline asset under Module BO.
Geographical applicability	Global. The methodology imposes no location-based eligibility restriction; eligibility is governed by the demonstration of additionality (Section 6).
Limitations	Continuous fossil-fuel co-firing is prohibited (fossil fuel is restricted to metered ignition, start-up and to limited emergency backup). Hydropower activities shall meet the power-density thresholds of Section 3.2. Activities under Modules ST, CG and VPP require verifiable digital telemetry.

	All primary generation and storage equipment, including components added or replaced under Module BO, shall be newly manufactured. The methodology generates emission reductions only.

2| DEFINITIONS

2.1.1 | The definitions in the Glossary of Gold Standard for the Global Goals shall apply, together with the definitions in the methodological tools referenced in Section 4.

2.1.2 | **Order of precedence.** Article 6.4 Rules, Modalities and Procedures (RMPs) and the GS4GG requirements, including ESE Activity Requirements prevail over this methodology. This methodology prevails over the tools and other documents it references, including MT400-06, the other GS4GG PAA tools and the Article 6.4 tools as modified by the GS4GG addenda, to the extent of any deviation it expressly states in its quantification or additionality provisions (for example, the common-practice provisions of Section 6.6 and the build-margin treatment for storage in Annex 2). In all other respects the referenced tools apply as published.

2.1.3 | The following terms are defined for the G-RESET methodology:

Table 2. Terms and definitions

TERM	DEFINITION
Accompanying Methodology	An approved GS4GG methodology applied in combination with this methodology to quantify mitigation outcomes outside the Power Generation Component (e.g., methane destruction, organic-waste diversion, thermal-energy supply, biogenic carbon, waste heat recovery). Where used, the boundary between the two methodologies shall be delineated so that no source, parameter or emission reduction is counted under both (Section 10).
Activity Cluster	Two or more activities or VPAs treated as one for the determination of scale under Section 3.5.
Activity Module	A discrete, selectable component of the methodology that quantifies a specific systemic function: • Greenfield Generation (Module GG); • Brownfield & Asset Optimisation (Module BO); • Energy Storage & Time-shifting (Module ST); • Captive Generation (Module CG); or • Virtual Power Plants (Module VPP). A module is applied only where its applicability conditions (Section 3.2) are met; modules may be applied independently

	or combined within a single activity, subject to the boundary-delineation and double-counting rules (Sections 5.1 and 11.3) and to additionality being demonstrated for each module (Section 6). Modules are not freely interchangeable.
Aggregation Reconciliation Waiver	A monitoring provision available to any configuration in which generation or storage is distributed across a large number of nodes, each below the utility-scale threshold, such that revenue-grade metering at every node would be disproportionate, including aggregated distributed resources under Module VPP and Programmes of Activities (PoA) comprising distributed captive or small-scale generation (Section 16). Under the waiver, aggregated telemetry may be sourced from original-equipment-manufacturer or platform interfaces at a lower metering-accuracy class than the revenue-grade requirement of Section 3.4, subject to a conservative metering discount (Section 14) and reconciliation against an independent utility settlement record.
Backup Generator	An auxiliary power generating unit within the activity boundary that supplies the activity's own equipment during an emergency or contingency event.
Battery Energy Storage System (BESS)	A rechargeable storage system of electrochemical cells (including flow batteries), power-conditioning systems and controls, designed to store and dispatch electricity for temporal carbon arbitrage and/or grid flexibility – subject to compliance with GS4GG Technical addendum to the A6.4 Grid Emission Factor Tool.
Brownfield Activity / Asset Optimisation	An intervention that alters an existing grid-connected power plant (through capacity addition, retrofit, rehabilitation, replacement or repowering) such that only the incremental generation attributable to the intervention is credited (Module BO).
Capacity Addition	An investment that increases the installed power-generation capacity of an existing plant through the installation of new, physically distinct generation units, where the existing units continue to operate after implementation.
Captive Generation	Renewable generation or storage supplying a captive or contracted consumer (behind the meter, via wheeling or open access, or via a dedicated line) to displace captive fossil-fuel generation or high-carbon grid imports (Module CG). A single distributed energy resource supplying a captive load falls under Module CG; the coordinated aggregation of multiple distributed energy resources falls under Module VPP.

Captive consumer	An electricity consumer supplied by the activity's renewable energy plant under a captive arrangement (consumer and plant owned by the same activity participant) or a contracted arrangement (e.g., a group-captive structure or a corporate power purchase agreement), delivered behind the meter, via wheeling, or via a dedicated line, rather than through general grid supply (Module GG). The producer and the consumer may be different legal entities, including group-captive and corporate power-purchase structures, provided the delivery is physical as described and the contracted arrangement is evidenced. A purely financial or virtual power-purchase agreement, under which no electricity of the activity is physically delivered to the consumer, does not constitute captive or contracted supply; such an activity is assessed under Module GG as grid supply.
Combined Margin (CM) emission factor	The grid emission factor combining the operating margin and build margin of an electricity system, determined under A6.4-AMT-007 (as modified by the applicable GS4GG Technical addendum to the A6.4 Grid Emission Factor Tool). It is applied as the emission factor for grid-displacing output: Module GG; the incremental generation of Module BO (the quantity of which follows the Declining Baseline); Module CG where the activity displaces grid import; and the net-new distributed generation aggregated under Module VPP.
Conservative Replacement Rule	A procedure for telemetry gaps under which missing data are neither interpolated nor omitted: electricity exported, discharged or supplied to captive user (baseline side) is set to zero for the gap, while energy imported or fuel consumed (activity side) is set to its maximum plausible value, so that gaps can never inflate reductions. For Module VPP, the Aggregation Reconciliation Waiver applies in place of this rule (Section 14).
Curtailment	The deliberate reduction of available renewable generation below its productive capacity, typically owing to network or system constraints. Where a storage asset verifiably charges from co-located generation that would otherwise have been curtailed, the charging emission factor may be set to zero under Module ST - subject to the evidentiary requirements of Annex 2.
Declining Baseline	A dynamic counterfactual for Brownfield activities (Module BO) in which the generation of the pre-existing asset, established from a representative recent operating year, degrades using standardised degradation rates until the asset reaches the end of its Remaining Useful Life, at which point the crediting under

	Module BO ceases (counterfactual is set to zero), preventing perpetual crediting of ageing infrastructure. The representative recent operating year is established as the resource-normalised mean of the three most recent full operating years; where inter-annual variability of generation exceeds 10%, the more conservative of the mean and the median shall apply. The normalisation basis and data are documented in the PDD (Annex 1).
Dedicated line	A direct electricity transmission or distribution line delivering the activity's generation to a specific captive or contracted consumer without conveyance through the public grid.
Digital Aggregation Perimeter	The logical boundary of a Module VPP activity, defined by the cloud platform that maps and dispatches the participating distributed energy resources, in place of a contiguous geographic boundary. Additionality, common practice and scale are assessed at this perimeter — at the aggregator/platform level — not at the individual household or asset level (Sections 6 and 16).
Digital MRV (dMRV)	Digital measurement, reporting and verification using automated data-acquisition systems, such as advanced metering infrastructure (AMI), Supervisory Control and Data Acquisition (SCADA) telemetry, application-programming-interface (API) integrations, and Earth-observation (EO) satellite data. Data architecture shall be proportionate to activity scale (Section 3.4).
Distributed Energy Resource (DER)	A generation, storage or controllable-load asset connected at distribution level or behind the meter, for example rooftop solar, residential batteries, or vehicle-to-grid (V2G) chargers.
Electricity system (grid)	An interconnected transmission and distribution network, operated by a system operator, that conveys electricity from multiple generators to multiple consumers. A mini-grid is an isolated, locally operated network not synchronously connected to a national or regional electricity system. Off-grid denotes generation serving a consumer with no connection to any electricity system or mini-grid. Off-grid and un-electrified-population configurations are addressed by the exclusions of Section 3.2.
Embodied Emissions	The GHG emissions from the manufacture, transport and installation, and end-of-life of material-intensive hardware (e.g., PV modules, wind turbines, battery cells, marine converters), accounted for as leakage. The system boundary is

	set out in Annex 3, Section A 3.3. Default factors are given in Annex 1, Sections A 1.4 and A 1.5.
End-of-Life (EoL) Decommissioning Plan	A provisioned and demonstrably feasible plan for safe recycling, disposal and site remediation of material–intensive hardware at the end of technical life, commensurate with the activity's scale and the host jurisdiction's waste infrastructure, assessed at validation (Section 3.2). For aggregated distributed assets (Module VPP), the requirement is met by the aggregator's participation in an extended-producer-responsibility or take-back scheme. Progressive capitalisation of the End-of-Life Plan means the periodic accrual of the estimated decommissioning and recycling cost across the crediting period, evidenced in audited financial statements or in a dedicated instrument; a dedicated escrow, bond or insurance instrument is required only where host-country law so requires or where the End-of-Life Plan itself relies on such an instrument.
Greenfield Power Plant	A renewable energy power plant constructed and operated at a site where no power plant of the same generation technology operated prior to the activity. A site at which a power plant of the same technology previously operated is treated as a Brownfield Activity (Module BO), even where the prior plant has been retired (see Repowering and the Declining Baseline)
Hourly (Locational) Marginal Emission Factor (HLMEF)	The emission factor representing the carbon intensity of the marginal generation served or displaced on the system during a specific hour (and, where applicable, node), used under Tier 2 of Tiered Temporal accounting.
Ignition and Start-up Sequence	The period from burner light-off until the unit first reaches its minimum stable generation after synchronisation, as shown by timestamped operating records.
Integrated Solution	An activity configuration in which two or more Activity Modules are co-located or operationally linked at design (for example, a solar plant combined with a battery, or a repowered wind farm with a co-located battery), each module retaining its own baseline and additionality demonstration.
Legacy Activity / Transitioning Activity	An existing activity previously registered under a legacy framework or an earlier GS4GG version (using CDM ACM0002, AM0123, AMS-I.D and AMS-I.F) that transitions to this methodology in accordance with the applicable GS4GG transition procedure - at crediting-period renewal, or earlier, including in order to add new modules.

New (newly manufactured) equipment	Generation or storage equipment that has not previously been operated, registered or credited under any crediting activity, and that is installed for the first time under the activity.
Non-conforming Month	A calendar month that fails a fossil-fuel condition of Section 8.3. No emission reductions are credited for a non-conforming month.
Open access	A non-discriminatory regulatory provision permitting a buyer and seller to use the transmission and distribution system to contract electricity supply, subject to applicable wheeling, transmission and cross-subsidy charges.
Power Density	The ratio of installed generation capacity of a hydropower or pumped-hydro facility to the surface area of its associated reservoir(s), in W/m², used to determine reservoir-emission eligibility and penalties (Section 3.2).
Power Generation Component	The portion of an activity comprising the generation of electricity and its export to an electricity system or supply to a captive load. Where an installation produces multiple energy carriers or mitigation outcomes (for example a landfill-gas, biogas, biomass or waste-heat-recovery facility that also destroys methane, diverts organic waste or supplies heat), this methodology quantifies only the reductions attributable to the grid-connected or captive power generation component.
Pumped Hydro Storage (PHS)	A form of hydroelectric energy storage comprising two reservoirs at different elevations, generating power on discharge and absorbing power on pumping. Treated as energy storage under Module ST for the purpose of temporal accounting; a PHS facility with a reservoir nonetheless remains subject to the hydropower power-density eligibility thresholds (Section 3.2) and to reservoir-emission accounting (Section 8.5).
Rehabilitation (refurbishment)	An investment to restore units that were severely damaged or degraded, primarily to restore performance, which may incidentally increase efficiency or capacity.
Remaining Useful Life (RUL)	For an existing asset, the period remaining at the activity start date until the end of its technical lifetime under A6.4-AMT-006, read with the GS4GG technical-lifetime addendum. The RUL governs the duration and decay of the Declining Baseline.
Replacement	An investment in new units, of the same or higher capacity, that replace one or more existing units at an existing plant.

Repowering	The replacement or comprehensive upgrade of an ageing renewable energy plant at the end of its useful life with new generation equipment; treated under the Declining Baseline.
Retrofit	An investment to repair or modify existing operating units to increase their efficiency, performance or capacity, without adding new units.
Round-Trip Efficiency (RTE)	The ratio of energy discharged from a storage system to the energy used to charge it. The associated conversion losses are captured as activity emissions by quantifying charging on a gross (imported) basis and discharging on a net (exported) basis.
System Outage	Unavailability of the grid connection at the activity's point of interconnection, evidenced by system-operator or utility records.
Technical Lifetime	The period over which equipment can be expected to operate as intended, determined under A6.4-AMT-006. Emission reductions are creditable only while the relevant assets remain within their technical lifetime.
Tiered Temporal Accounting	A two-tier framework for assigning grid emission factors to charging and discharging in time. Tier 1 (Time-of-Use) maps the emission factor to standardised daily load blocks and is permitted where hourly data are unavailable, subject to a conservativeness discount; Tier 2 (Hourly Marginal) applies temporally resolved hourly factors and applies where the system operator publishes, or can supply, the necessary data. Data readiness and the transition between tiers follow Section 3.2 and the GS4GG Technical addendum to the A6.4 Grid Emission Factor Tool.
Universal Core	The set of requirements applying to every activity irrespective of the modules selected, comprising the common provisions on boundary, baseline, additionality, leakage, monitoring, uncertainty and double-counting.
Utility-scale	An activity whose installed generation capacity exceeds 5 MW or whose installed storage energy capacity exceeds 5 MWh. For the End-of-Life Plan requirement (Section 3.2) the threshold is assessed, for aggregated configurations, at the aggregate level. For the metering-architecture requirement (Section 3.4) the threshold is assessed at the level of each generation or storage unit's metering point. The utility-scale marker is independent of the GS4GG small-scale and micro-scale classification, which is governed by the Principles and Requirements.

Virtual Power Plant (VPP)	A cloud-based aggregation of heterogeneous DERs, coordinated for dispatch, trading or grid services as if a single facility (Module VPP). A VPP is treated as standalone activity or VPA, bounded by its Digital Aggregation Perimeter; its baseline inherits the Module GG (net-new distributed generation) and Module ST (aggregated storage flexibility) engines, and the captive MIN rule does not apply to it (Sections 6, 7 and 16).
Wheeling	An electricity-transmission service delivering the activity's renewable electricity to a captive or contracted consumer over the transmission and distribution system under a power purchase agreement (including open-access arrangements), with no material time lapse between generation and consumption.

3| SCOPE, APPLICABILITY, AND ENTRY INTO FORCE

3.1 | Scope

3.1.1 | This methodology applies to activities that introduce, optimise, store, or dispatch renewable energy to reduce or avoid greenhouse gas (GHG) emissions from grid-connected or captive systems.

3.1.2 | To accommodate the physical realities of the modernising power system, the methodology uses a modular architecture. An activity developer structures the activity by applying the universal core requirements together with one or more Activity Modules, selected according to the physical function of the intervention:

a.| **Module GG: Greenfield Generation -** new renewable power plants generating net-new electricity for an electricity system. Eligible technologies are solar (photovoltaic and thermal), wind (onshore and offshore), hydropower (subject to safeguards), geothermal, marine (wave and tidal), and, for their power-generation component only (Section 3.1.5), sustainable biomass, biogas, landfill gas (LFG) and waste-heat recovery (WHR).

b.| **Module BO: Brownfield & Asset Optimisation -** capacity additions, retrofits, rehabilitations, replacements and repowering of existing plants, crediting only the incremental generation through a Declining Baseline.

c.| **Module ST: Energy Storage & Time-shifting -** standalone or integrated electricity storage of any medium (BESS, pumped hydro, thermal, flow, and other electrochemical or mechanical media), crediting the carbon delta between charging and discharging intervals using Tiered Temporal Accounting.

d.| **Module CG: Captive Generation -** renewable generation or storage supplying a captive or contracted consumer (behind the meter, via

wheeling or open access, or via a dedicated line) to displace captive fossil-fuel generation or high-carbon grid imports. A single distributed energy resource supplying a captive load is eligible under this module without being aggregated into a VPP.

e.| **Module VPP: Virtual Power Plants -** The coordinated aggregation of distributed energy resources into a virtual power plant, bounded by its Digital Aggregation Perimeter, exporting electricity to the electricity system or time-shifting electricity through storage. The Module VPP baseline inherits the Module GG approach for aggregated net-new distributed generation and the Module ST approach for aggregated storage flexibility; the captive MIN rule does not apply.

3.1.3 | Modules may be applied as independent solutions (e.g., a standalone grid-connected battery under Module ST) or as Integrated Solutions (e.g., Module BO + Module ST for a repowered wind farm with a co-located battery), each module retaining its own baseline and additionality demonstration.

3.1.4 | Two further functions are reserved for future versions and are not eligible under Version 1.0: Grid Stability & Ancillary Services and Demand-side Flexibility.

3.1.5 | **Power-generation component and combination with accompanying methodologies**: This methodology may be applied on a standalone basis or in combination with one or more Accompanying Methodologies.

a.| Where an installation generates electricity from a fuel or process that also produces a distinct mitigation outcome (for example methane destruction at a landfill or anaerobic digester, organic-waste diversion, or the recovery of waste heat), this methodology quantifies only the reductions attributable to the power-generation component (the electricity exported to the system or supplied to a captive load and the fossil generation it displaces). All other outcomes shall be quantified under the relevant Accompanying Methodology (for example, A6.4-AMM-001 for landfill gas).

b.| Where an accompanying methodology is used, the activity developer shall delineate the boundary between the two methodologies such that no emission source, parameter or emission reduction is quantified under both (Section 11). Biogenic CO_2 from the combustion of sustainably sourced biomass, biogas or LFG is treated in accordance with the Accompanying Methodology and the prevailing IPCC guidance and shall not be double-counted.

3.2 | Applicability

3.2.1 | Core Applicability Requirements (all modules)

a.| **Equipment Status Rule:**

i. All primary generation and storage equipment used to generate reductions, including new components added or replaced under Module BO, shall be newly manufactured.

ii. Any existing, operational, generation equipment, replaced or repowered, under Module BO shall be verifiably decommissioned, recycled, or disposed of where feasible in the host jurisdiction to a documented best-effort standard verified by the Validation and Verification Body (VVB).

Where replaced equipment is sold for continued operation rather than decommissioned, the activity developer shall demonstrate that its continued operation is not claimed under any other crediting activity and shall report its disposition.

b.| **Baseline data vintage:** Any historical generation data (Module BO) shall be no older than three (3) years prior to submission of the PDD to VVB or the date of crediting-period renewal. Data used to derive grid emission factors shall meet the vintage and resolution requirements of the GS4GG Technical addendum to the A6.4 Grid Emission Factor Tool.

c.| **Digital telemetry readiness (Modules ST, CG & VPP):** Activities under Modules ST,CG and VPP shall be equipped for automated digital metering and telemetry proportionate to their scale (Section 3.4). Activities incapable of verifiable digital telemetry are not eligible under these modules.

d.| **Tiered Temporal data readiness (Modules ST,CG and VPP):** The host system shall support Tiered Temporal Accounting and shall apply Tier 2 (hourly marginal) where the relevant data are published by, or procurable from, the transmission system operator. Where such data are not yet available, Tier 1 (time-of-use proxy blocks) applies, subject to a conservativeness discount and the activity shall upgrade to Tier 2 at the next crediting-period renewal at which the host system publishes the necessary data, in accordance with the data-readiness pathway of the GS4GG Technical addendum to the A6.4 Grid Emission Factor Tool .

e.| **No location-based restriction.** This methodology imposes no eligibility restriction based on the host country's classification. Eligibility is governed by the demonstration of additionality in Section 6 and the applicability conditions of this Section.

3.2.2 | Module-specific applicability

a.| **Module GG (Greenfield):**

i. A Greenfield Power Plant is one constructed at a site where no power plant of the same generation technology operated previously; a site that previously hosted a same-technology plant is a Brownfield Activity (Module BO).

ii. Combustion and waste-gas technologies (biomass, biogas, LFG, WHR) are eligible only for their power-generation component, subject to Section 3.1.5 and the safeguards in Section 3.4.

b.| **Module BO (Brownfield).**

i. Applicable to capacity additions, retrofits, rehabilitations, replacements and repowering.

ii. The pre-existing asset shall, at the activity start date, possess a certified Remaining Useful Life (RUL) of at least five (5) operating years before the end of its technical lifetime determined under A6.4-AMT-006 read with GS4GG addendum; assets below this threshold are deemed to be undergoing business-as-usual replacement, and no reductions are credited for historical displacement (the Declining Baseline is set to zero). The RUL shall be evidenced by an original-equipment-manufacturer certification or an independent engineering assessment applying A6.4-AMT-006 read with the GS4GG addendum; where both exist, the more conservative governs, and for refurbished or partially replaced assets the assessment shall address the refurbished components expressly.

iii. Verifiable historical generation data meeting the baseline-data vintage requirements are required.

c.| **Module ST (Storage).**

i. Applicable to storage of any medium, standalone or integrated with generation. Where a storage asset verifiably charges from co-located generation that would otherwise have been curtailed, the charging emission factor may be set to zero, subject to the evidentiary requirements of Annex 2, which admit, in addition to a timestamped system-operator curtailment instruction, a wholesale price at or below a defined short-run floor, and, for systems lacking published locational prices, a physical would-be-curtailment demonstration (metered co-located renewable generation exceeding on-site load plus export capacity in the charging interval).

ii. A storage asset co-located and DC-coupled to a renewable plant and technically restricted from grid charging incurs zero charging emissions.

d.| **Module CG (Captive).**

i. Applicable to renewable generation or storage supplying a captive or contracted consumer — (i) behind the meter, (ii) via wheeling/open access through the grid under a power purchase agreement, or (iii) via a dedicated line. Delivery shall be physical: a purely financial or "virtual" power purchase agreement (a contract-for-difference or unbundled-attribute arrangement with no physical

delivery of the activity's electricity to the consumer behind the meter, via wheeling, or via a dedicated line) does not qualify under this module.

ii. The displacement of captive fossil generation (e.g., diesel gensets) is quantified against a captive baseline (Section 7) under the MIN(captive fossil, grid) rule; where a consumer draws simultaneously from a captive generator and the grid, the MIN(captive, grid) rule of Section 7 applies.

iii. The following conditions apply: (a) in the pre-activity scenario, the captive/contracted consumer does not source the displaced load from a renewable energy source; (b) the renewable plant is contractually bound to supply that consumer for at least the duration of the crediting period; (c) where the plant also exports to the grid, the grid-exported portion is credited, if at all, under Module GG, not Module CG; and (d) storage integrated under this module follows Module ST (Tiered Temporal Accounting).

e.| **Module VPP (Virtual Power Plant).**

i. Applicable to the coordinated aggregation of distributed energy resources into a virtual power plant, bounded by its Digital Aggregation Perimeter. Additionality, common practice and scale are assessed at the aggregator/platform level (Section 6 and 16), not at the individual household or asset level.

ii. The baseline applies the Module GG engine (Combined Margin) to aggregated net-new distributed generation and the Module ST engine (Tiered Temporal Accounting) to aggregated storage flexibility; the captive MIN rule does not apply.

iii. Monitoring may apply the Aggregation Reconciliation Waiver (Section 14). Aggregate-capacity thresholds for safeguards are determined under Section 3.2 (Supply Chain, E-Waste & Embodied Carbon).

3.2.3 | Ineligible Activities

a.| Continuous co-firing of biomass with fossil fuel, or any fossil-fuel combustion for the credited generation other than metered ignition and start-up and backup operation within the conditions of Section 3.2.4 (b) and section 8.3.

b.| Under Modules GG and BO, activities whose most plausible baseline is the continued operation of an existing fossil-fuel plant at the site (fossil-to-renewable fuel switching), since the Module GG or BO baseline is grid displacement and not fossil continuation. This does not exclude the displacement of captive fossil generation under Module CG.

c.| Activities serving a previously un-electrified population and an activity relying on a suppressed-demand baseline (including activities transitioning from CDM AMS-I.A, AMS-I.F or AMS-I.L on that basis), are

ineligible under this methodology and shall apply a dedicated GS4GG energy-access methodology; this methodology credits only the displacement of actual, metered generation. The displacement of existing, metered captive fossil generation serving productive, commercial or institutional use is eligible under Module CG irrespective of the location of the consumer.

d.| Under Module BO, transmission-and-distribution (T&D) network loss-reduction or efficiency-improvement measures. Module BO covers generation-asset optimisation (capacity additions, retrofits, rehabilitations, replacements and repowering) only; T&D loss reduction is a distinct activity class outside the generation boundary of this methodology and is not credited under Module BO or any other module.

e.| Activities seeking to credit GHG removals; this methodology generates emission reductions only.

3.2.4 | **Technology-Specific Requirements**:

a.| **Hydropower Safeguards (Modules GG, BO & ST)**:

i. Power Density > 10 W/m^2 (no reservoir emissions applied).

ii. Where the Power Density is between 4 W/m^2 and 10 W/m^2 (the lower bound exclusive; i.e. 4 < power density ≤ 10 W/m^2), a default reservoir-emission factor shall be deducted as activity emissions (Section 8).

iii. New reservoirs, or the expansion of existing reservoirs, with a Power Density ≤4 W/m^2 are ineligible.

iv. For the purposes of this methodology, a hydropower plant is run-of-river where its impoundment does not exceed 24 hours of storage at design flow and its hydraulic residence time (the impoundment volume divided by the mean inflow) is below two days; a plant that does not meet both conditions is assessed as a reservoir plant. All hydropower activities with a reservoir, and all large-scale (> 15 MW) hydropower activities, shall undergo an independent assessment against the Hydropower Sustainability Standard (or its successor), consistent with the ESE Activity Requirements. The 15 MW threshold is assessed on the Activity Cluster where Section 3.5 applies

b.| **Biomass, biogas, landfill gas and waste-heat recovery (Modules GG & BO):**

i. Continuous fossil co-firing is prohibited. Fossil fuel is restricted to metered ignition and start-up and backup operation, logged and deducted as activity emissions. Electricity derived from fossil fuel shall not exceed 5% of the activity's electricity generation in any calendar month. Section 8.3 sets out the test and its consequence.

ii. Backup generators shall be used solely to maintain system continuity and safety during emergency or contingency events, and not to supply electricity to the electricity system or to consumers. Fossil-fuelled backup operation is limited to 100 operating hours in each calendar year, excluding periods of officially declared disaster or system outage, and is logged and deducted.

iii. Feedstock sourced from high-carbon-stock land (e.g., primary forest, peatland) is prohibited.

c.| **Geothermal (Modules GG and BO).**

i. Fugitive emissions of non-condensable gases and working fluids shall be quantified as activity emissions (Section 8).

ii. Given the wide range of geothermal emission intensities, geothermal activities shall pass the emission-intensity eligibility screen of Annex 6, A.6.4.

d.| **Marine & Coastal Safeguards (Wave/Tidal):**

i. The activity shall provide an independent environmental impact assessment demonstrating no significant disruption to critical benthic habitats (e.g., coral reefs, seagrass beds) or marine migratory corridors.

ii. The activity shall establish an End-of-Life Plan (Section 2) providing for removal and recycling of submerged infrastructure.

e.| **Supply Chain, E-Waste & Embodied Carbon Safeguards (All Modules):**

i. The embodied emissions of material-intensive hardware (PV modules, wind turbines, battery cells, marine converters) shall be deducted as leakage (Section 9.4), using the default factors in Annex 1 or an activity-specific factor under Annex 3, Section A 3.9.

ii. Utility-scale hardware (generation above 5 MW or storage above 5 MWh) shall establish an End-of-Life Plan (Section 2), assessed at validation and reviewed at each issuance. For Module VPP this threshold applies to the aggregate installed capacity of the participating distributed energy resources: where the aggregate exceeds the threshold, the requirement is met by the aggregator's participation in a collective extended-producer-responsibility or take-back scheme, even where each individual asset falls below the threshold. The threshold is assessed on the Activity Cluster where Section 3.5 applies.

iii. **Progressive capitalisation (End-of-Life Plan):** The periodic accrual of the estimated decommissioning and recycling cost across the crediting period, evidenced in audited financial statements or in a dedicated instrument. A dedicated escrow, bond or insurance

instrument is required only where host-country law so requires or where the End-of-Life Plan itself relies on such an instrument.

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 | The activity shall comply with the GS4GG Principles and Requirements, the Safeguarding Principles and Requirements, and the Energy Systems and Efficiency (ESE) Activity Requirements, including the "Do No Harm" principle and the Sustainable Development assessment. The stakeholder-consultation and sustainable-development processes are documented in the applicable GS4GG templated documents at the activity level; this section states the safeguards that condition eligibility. For a PoA, that documentation operates at the level of the VPA in accordance with the Programme of Activities Requirements and Procedures.

a.| **Digital MRV (dMRV) readiness:** Electricity generation, charging, discharging and captive consumption shall be measured with digital metering capable of automated SCADA or API telemetry.

i. For each metering point exceeding 5 MW (generation) or 5 MWh (storage), and for standalone Modules ST and CG above that marker, metering shall be revenue-grade advanced metering infrastructure meeting the accuracy tier of Annex 4 (A 4.2.1).

ii. For metering points at or below that marker, a proportionate data architecture (for example a programmable logic controller in place of a full SCADA system) is permitted, provided the applicable accuracy tier of A 4.2.1 and the calibration requirements are met.

iii. For aggregated distributed resources (Module VPP), and for PoAs aggregating distributed captive or small-scale generation (Section 16), the Aggregation Reconciliation Waiver of Section 14 applies. Manual meter reading is not permitted for Modules ST, CG and VPP.

b.| **Power quality:** New generation and storage assets shall not cause the host network to breach the voltage, frequency, flicker and harmonic-distortion limits of the applicable IEC standards (e.g., IEC 61000 series) or the national grid code, where applicable. Compliance is demonstrated at validation and monitored where the system operator imposes power-quality obligations.

c.| **Avoidance of double counting.**

i. The electricity generated or discharged shall not additionally be monetised as renewable energy certificates, I-RECs or guarantees of origin unless the corresponding attributes are verifiably cancelled (Section 11). Where no attribute registry or issuance mechanism operates in the host market, cancellation is evidenced by: a

declaration in each monitoring report that no such attributes have been issued, sold or claimed for the metered output; a contractual waiver of attribute claims by each off-taker; and, where an issuer nonetheless exists, by status verification by the VVB.

ii. Where the activity is combined with an Accompanying Methodology, the boundary rules of Section 3.1 apply.

d.| **Specialist studies:** A specialist study required by this methodology (including wake and shadowing assessments, land-use-change carbon-stock calculations, embodied-emission derivations, hydrological assessments and storage dispatch studies) shall be prepared by a suitably qualified expert: a person (e.g., a licensed professional engineer or accredited environmental consultant) or body demonstrably competent and experienced in the relevant discipline, independent of the activity developer except where this methodology expressly permits a regulator-supervised assessment (A 1.14). The study shall identify its preparer, the preparer's qualifications and the standard or model applied.

3.5 | Scale Determination and De-bundling

3.5.1 | Scale is determined for each activity or VPA. A PoA may include any number of VPAs; no limit applies at programme level.

3.5.2 | The micro-scale threshold of the Positive List (Section 6.2), the common-practice exemption (Section 6.6), and the End-of-Life Plan and Hydropower Sustainability Standard thresholds (Section 3.2) are assessed on the Activity Cluster where Section 3.5.3 applies. An activity or VPA that forms part of a cluster above a threshold shall not use the simplification or exemption the threshold grants and shall meet the obligations that apply above it.

3.5.3 | Two or more activities or VPAs applying this methodology form one Activity Cluster where they are under common beneficial ownership or common operational control, whether registered under different participants or legal entities, and at least one of the following applies:

a.| they share a point of interconnection (substation or feeder) or, for captive supply, a consumer 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.

3.5.4 | The scale of an Activity Cluster is the total of the scale of its members, each measured on the convention of Section 1 (installed capacity, or annual emission reductions for the micro-scale threshold), except that for the common-practice exemption the capacity of solar PV is its DC rating.

3.5.5 | Activities or VPAs held by distinct beneficial owners, each controlling its own assets, are not grouped solely because they use a common coordinating entity, aggregator, VPP platform, PoA or monitoring service.

3.5.6 | At validation, at each VPA inclusion and at each verification, the activity developer shall disclose the coordinates of each installation, its beneficial ownership and operational control, any shared point of interconnection or consumer site, and any capacity added since the previous disclosure that meets the criteria of Section 3.5.3. The VVB shall confirm the cluster boundary.

3.5.7 | A new activity or VPA that forms an Activity Cluster with an existing one is assessed on the cluster, including itself, and does not benefit from any simplification or exemption whose threshold the cluster exceeds. Capacity added to an existing activity is assessed under the GS4GG Design-Change Request Requirements and Procedures on the capacity after the change. The existing activity keeps the status determined at its validation or inclusion until the end of its current crediting period and is assessed on the cluster as it then stands at renewal. Obligations that apply above a threshold in Section 3.2 apply from the first verification after the cluster exceeds it.

3.5.8 | Where information required by Section 3.5.6 was withheld or misstated, the activity is treated as part of the Activity Cluster from its validation or inclusion, and the matter is addressed as a non-conformity under the GS4GG rules.

4| NORMATIVE REFERENCES

4.1.1 | The following standards, methodologies, tools, and guidelines are normative references for the application of this methodology. For each crediting period, the version applied of each document is the latest valid version at design certification or at crediting-period renewal, as applicable, and remains fixed for that crediting period, except where Gold Standard designates an update as applying with immediate effect under the GS4GG version and transition rules; the applicable Product Requirements and methodology standards govern. The applicability conditions contained in the methodological tools listed below apply in addition to the conditions in Section 3.2. The order of precedence set out in Section 2 governs any inconsistency.

4.1.2 | **Binding status of the Annexes:** The Annexes to this methodology form an integral and binding part of this methodology. The default values, emission factors and assessment conventions set out in the Annexes are mandatory. An activity developer may depart from a default value only toward a more conservative value, or where the methodology expressly permits a third-party-verified activity-specific value (Annex 1).

4.1.3 | **GS4GG Standards and Requirements**

a.| Principles and Requirements

b.| Safeguarding Principles and Requirements

c.| GHG Emissions Reductions & Sequestration Product Requirements

d.| Energy Systems and Efficiency (ESE) Activity Requirements

e.| Hydropower Sustainability Standard (Hydropower Sustainability Council), for the independent assessment required by Section 3.2.4(a)

4.1.4 | **GS4GG Methodologies, Standards, and Tools (PAA M400 series)**

a.| Methodology Standard: Requirements for Additionality Demonstration (V1.0)

b.| Methodology Standard: Requirements for Baseline Determination (GS4GG PAA MS400-04) (V1.0)

c.| Methodology Standard: Requirements for Addressing Leakage in Methodologies (GS4GG PAA MS400-05) (V1.0)

d.| Programme of Activities Requirements and Procedures (applicable where the activity is implemented as a PoA — see Section 16)

e.| Design Change Request Requirements and Procedures (applicable to capacity added after validation, see Sections 3.5 and 16)

f.| Methodology Tool 01: Emissions from Fossil Fuel Consumption (GS4GG 400 MT001) (V1.0)

g.| Methodology Tool 05: Downward Adjustment Factor (DAF) Determination (MT400-05) (V1.0)

h.| Methodology Tool 06: Common Practice Tool (MT 400-06) (V1.0)

i.| Methodology Tool 08: Technical Addendum to the A6.4 Technical Lifetime of Equipment (V1.0)

j.| Methodology Tool 10: Technical Addendum to the A6.4 Grid Emission Factor Tool (V1.0)

k.| Methodology Tool 9: Analysis of Lock-in risk (V1.0)

4.1.5 | **UNFCCC/A6.4 Tools and Standards:**

a.| Methodology tool: Investment analysis (A6.4-AMT-002) —for the demonstration of financial additionality (Section 6).

b.| Methodology tool: Determination of the technical lifetime of equipment (A6.4-AMT-006) —for determining creditable asset life and the Module BO Declining Baseline (Sections 1, 7 and 10).

c.| Methodological tool: Emissions from electricity generation and consumption (A6.4-AMT-007) —for grid emission factors, displaced-electricity quantities and grid-charging emissions (Sections 7 and 8).

d.| Methodology: ACM0002 - Grid-connected electricity generation from renewable sources (V22.0)

e.| Methodology: AM0123 - Renewable energy generation for captive use (V1.0)

f.| Methodology: AMS-I.D.- Grid connected renewable electricity generation (V18.0)

g.| Methodology: AMS-I.F — Renewable electricity generation for captive use and mini-grid (V5.0)

4.1.6 | **Informative references:**

a.| IPCC (2006), 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 2 (Energy).

b.| IPCC (2019), 2019 Refinement to the 2006 IPCC Guidelines, Volume 1 (General Guidance and Reporting).

c.| IPCC Assessment Report Global Warming Potential (GWP-100) values, as adopted by the CMA under the applicable GS4GG requirements (currently AR5; the operative GWP value is specified in Section 14).

d.| IPCC (2011), Special Report on Renewable Energy Sources and Climate Change Mitigation (SRREN).

e.| Life-cycle assessment sources underpinning the embodied-emission and degradation default factors (Annex 1 and 3).

5| ACTIVITY BOUNDARY AND GHG SOURCES/SINKS

5.1 | Activity boundary

5.1.1 | The activity boundary encompasses all anthropogenic GHG sources that are significant and reasonably attributable to the activity and required to be accounted under this methodology, whether or not they are under the direct operational control of the activity developer (for example, the displaced grid or captive generation, storage charging, and the embodied emissions of activity hardware).

5.1.2 | Because the methodology is modular, the boundary is module-dependent: it is determined by the Activity Module(s) deployed and fixed at validation. Any subsequent change to the boundary is effected only through the applicable certification including renewal of design certification, design change, VPA inclusion. The electricity system to which the activity is connected is defined in accordance with A6.4-AMT-007; the activity developer shall classify each deployed module under the applicable A6.4-AMT-007 scenario (below).

a.| **Module GG & Module BO:** The boundary encompasses the site of the renewable energy power plant, all physically distinct generation units (new, repowered, retrofitted or expanded units), any on-site backup or ignition generators, and all physical infrastructure up to the point of interconnection. For Module BO, the boundary isolates the upgraded or repowered units subject to the Declining Baseline.

b.| **Module ST:** The boundary encompasses the storage facility (of any medium), its power-conditioning systems, and the nodes of the electricity system from which it charges and to which it discharges. Systemically, the boundary captures the temporal carbon intensity of

the electricity system during the specific charging and discharging intervals, determined under Tiered Temporal Accounting (Section 8).

c.| **Module CG (Captive Generation):** The boundary encompasses the captive renewable or storage assets, the displaced captive fossil-fuel generators (e.g., diesel gensets), the captive or contracted consumer's load supplied by the activity (behind the meter, via wheeling, or via dedicated line), and the point of interconnection. Including the captive/contracted consumer's load is required to apply the MIN (captive, grid) emission factor (Section 7).

d.| **Module VPP.** The boundary is the Digital Aggregation Perimeter — the set of participating distributed energy resources mapped to the VPP's control platform — together with the nodes of the electricity system to which the aggregated resources export or on which they shift load. Aggregated net-new distributed generation is bounded as under Module GG, and aggregated storage flexibility as under Module ST.

e.| **Integrated Solutions (co-located modules):** Where two or more modules are co-located, the boundary between them shall be delineated so that electricity routed internally (for example, from the Module GG plant to a co-located Module ST battery) is excluded from the generation module's crediting and captured exclusively within the storage module's boundary and settlement reconciliation, to prevent double issuance. Such internally-routed renewable charging incurs zero charging emissions under Module ST.

5.1.3 | **Classification under A6.4-AMT-007 Scenarios:** In accordance with Step 2 of A6.4-AMT-007, the activity developer shall classify each deployed module under one of the following scenarios in the PDD:

a.| Scenario A (Grid only): Modules GG, BO, ST and VPP.

b.| Scenario B (Captive only): Module CG.

c.| Scenario C (Combined): Where the activity interacts with both the electricity system and a captive fossil-fuel plant. Scenario C shall be selected as a conservative approach where the circumstances cannot be classified as Scenario A or Scenario B

5.1.4 | **Power-generation component and combination with Accompanying Methodologies:**

a.| Where Module GG or Module BO is applied to a biomass, biogas, landfill-gas or waste-heat-recovery installation, the activity boundary of this methodology is limited to the power-generation component: the combustion or heat-recovery unit insofar as it generates electricity, the parasitic and fossil ignition/start-up energy of that unit, and the electricity it exports.

b.| The boundary excludes the upstream fuel or waste-management system (feedstock handling, anaerobic digestion, methane generation

and capture, and the destruction of methane) which lies within the boundary of an accompanying Methodology.

c.| The two boundaries shall be delineated so that no source, parameter or reduction falls within both.

d.| Every activity applying an Accompanying Methodology shall complete the Boundary Allocation and Reconciliation Table (Annex 5), recording, for each source and parameter, the data stream, the equation, the metering point, the evidence, and the responsible methodology.

e.| Where an Accompanying Methodology is not applied to a biomass, biogas, landfill gas, or waste-heat recovery activity, all upstream emissions (including feedstock cultivation, processing, transport, and fugitive methane emissions) shall be explicitly quantified as Activity Emissions or Leakage.

5.2 | GHG Sources and sinks

5.2.1 | Activity developers shall account only for the sources and gases that correspond to their activated Module(s). Consistent with the GS4GG baseline and leakage requirements and A6.4-AMT-007, a source may be treated as minor and excluded only where its omission is conservative (it is a baseline source whose exclusion lowers the credited reduction, or an activity/leakage source whose inclusion would not change the credited reduction) and it falls below a materiality threshold of one (1) per cent of the activity's estimated annual emission reductions; the exclusion and its basis shall be recorded in the PDD.

Table 3. GHG Sources included in, or excluded from, the activity boundary

SOURCE	MODULE	DESCRIPTION	GAS	INCLUDED?	JUSTIFICATION
Baseline emissions					
Grid electricity generation displaced by the activity	GG,BO,ST,CG,VPP	Displacement of fossil-fuel intensive grid electricity by net-new renewable generation or optimally time-shifted discharge.	CO_2	Yes	Primary mitigation outcome. Quantified via A6.4-AMT-007 using Tiered Temporal Accounting (Sections 7–8).
			CH_4 N_2O	No	Excluded for simplification and conservativeness, consistent with A6.4-AMT-007.
Captive fossil-fuel	CG	Displacement of behind-the-meter fossil-fuel generators	CO_2	Yes	Principal outcome in off-grid and weak-grid settings; quantified against the

generation displaced (behind the meter)		(e.g., diesel/HFO gensets) by captive RE or VPP dispatch.			captive baseline (Section 7).
			CH_4 N_2O	No	Excluded for simplification and conservativeness.
Activity Emissions					
Grid electricity imported to charge Storage/ pump PHS	ST,CG,VPP	Power imported from the grid to charge storage assets.	CO_2	Yes	Principal activity emission; quantified under the same Tiered Temporal track as the baseline, on a gross (imported) basis, applying the Case 1 (higher-value-conservative) provisions of A6.4-AMT-007.
			CH_4 N_2O	No	Excluded for simplification.
Fossil fuel combustion for start-up, ignition, or backup generators (All Modules)	GG, BO, ST, CG, VPP	Metered fossil fuels consumed by emergency backup generators or for brief ignition/start-up processes.	CO_2 (+CH_4, N_2O via factor)	Yes	Metered fossil fuel consumed for ignition, start-up and backup operation; CH_4 and N_2O captured via the non-CO_2 factor (Section 8.3). Continuous co-firing is prohibited. The fossil fuel cap, the co-firing traceability condition and the backup limit are tested for each calendar month (Section 8.3), a month that fails is not credited.
			CH_4 N_2O		
Fugitive emissions from geothermal operations (if applicable)	GG, BO	Release of non-condensable gases (NCGs), working fluids.	CO_2, CH_4,	Yes	Major source for open-cycle geothermal; quantified as an activity emission where geothermal is deployed (Section 8).
Reservoir emissions	GG, BO, ST	Biogenic methane emissions	CH_4	Yes	Accounted for where $4 < PD \leq 10$ W/m^2; not applicable above

(Hydropower / PHS)		(ebullition and degassing) from newly flooded lands or expanded reservoirs.			PD>10 W/m²; ineligible ≤4 W/m².
			CO_2, N_2O	No	Excluded for simplification.
Combustion of biomass, biogas or landfill gas for power	GG, BO		CO_2, CH_4 N_2O	No	Accounted for under the Accompanying Methodology excluded here to avoid double counting.
Upstream cultivation, processing, transport and fugitive emissions of biomass/bio gas/LFG feedstock	GG, BO		CO_2, CH_4 N_2O	Conditional	Mandatory inclusion where a biomass/biogas/LFG/ waste activity is registered WITHOUT an approved Accompanying Methodology (5.1); quantified as activity emissions / leakage.
Auxiliary grid electricity consumed by the generation plant	GG, BO		CO_2	Conditional	Included on a net basis where not already netted within net export (Section 8).
BESS fire-suppression agent release (Modules ST, CG, VPP)	ST, CG, VPP		High GWP>1 agents (e.g., HFC-227ea)	Conditional	Conditional: Included where GWP>1 agents are used (Annex-1); using AR5 100-year GWP values (Annex-1); zero for low-/zero-GWP agents.
Leakage Emissions					
Embodied emissions of activity hardware	GG, BO, ST, CG, VPP	Emissions from the manufacture, transport and installation, and end-of-life of material-intensive activity hardware (e.g., PV modules,	CO_2e	Yes	Mandatory deduction. Determined from the Annex 1 defaults or an activity-specific factor (Annex 3, Section A 3.9). Recovered within the crediting period (Section 9.4.3).

		battery cells, wind turbines).			
Baseline equipment transfer	GG, BO, ST, CG, VPP		CO_{2e}	No (resolves to zero)	Structurally eliminated by the Equipment Status Rule (Section 3.2); equipment is newly manufactured and replaced equipment is decommissioned where feasible or sold for continued operation, it shall not be claimed under any other crediting activity, and its disposition shall be reported.
Leakage — Wake / shadowing effects on adjacent third-party renewable plants	GG, BO		CO_2	Conditional	Included where an adjacent third-party wind or marine array loses yield owing to the activity's aerodynamic or hydrodynamic wake, quantified using a wake / wind-flow model (Section 9).
			CH_4, N_2O	No	Excluded for simplification.
Land-use change where land is converted (Modules 1, 2)	GG, BO,		CO_2	Conditional	Included where conversion occurs (Section 9). Amortised under eq. 39 and recovered within the crediting period through the true-up of Section 9.
Leakage — Upstream fossil-fuel extraction/transport; rebound effects	All		CO_2, CH_4, N_2O	No	Excluded; the omission is conservative under the GS4GG leakage standard (the excluded baseline upstream emissions outweigh these).

5.2.2 | **Baseline Emissions** are the GHG emissions that would have occurred in the absence of the activity - a dynamic counterfactual set conservatively per Section 7:

a.| **Modules GG, ST and VPP** — the grid emissions displaced by the electricity generated or net-discharged, resolved in time through Tiered Temporal Accounting.

b.| **Module BO** — the Declining Baseline decaying to zero at the end of the asset's Remaining Useful Life (A6.4-AMT-006).

c.| **Module CG** — the captive fossil generation or high-carbon grid import, displaced at lower of the captive or grid emission factor.

5.2.3 | **Activity Emissions** are the direct and indirect emissions arising within the boundary from implementing the activity (Section 8).

a.| For storage and flexibility (Modules ST, CG and VPP), round-trip-efficiency losses are captured by quantifying charging on a gross (imported) basis and discharging on a net (exported) basis.

b.| Where a storage asset verifiably charges from would be curtailed, co-located generation, the charging emission factor is set to zero (Section 8), subject to Annex -2.

5.2.4 | **Leakage Emissions** are quantified per the three-tier approach of the GS4GG leakage requirements (identify, minimise, quantify) and comprise

a.| Embodied emissions of activity hardware; baseline equipment transfer (resolving to zero); wake/shadowing on adjacent third-party plants; and land-use change where land is converted (Section 9).

b.| Embodied and land-use-change emissions are recovered within the crediting period (Section 9.4 and 9.5).

6| DEMONSTRATION OF ADDITIONALITY

6.1 | Requirements

6.1.1 | The activity shall demonstrate that it would not have occurred in the absence of the incentives provided by carbon revenue. The demonstration shall be conducted in accordance with the GS4GG Requirements for Additionality Demonstration and shall include, as a minimum and concluded positively in each case.

a.| Regulatory surplus (Section 6.3);

b.| Lock-in risk, where applicable to the technology (Section 6.4).

c.| Financial additionality, demonstrated through the Investment Analysis (Section 6.5); and

d.| Common practice (Section 6.6).

6.1.2 | For an activity deploying more than one Activity Module, additionality shall be demonstrated at the module level: the mitigation attributable to each module

shall be independently additional. Each module shall be assessed on the basis that the other co-located modules of the activity are present, not on the counterfactual that they are absent:

a.| a module whose financial or technical viability arises only from its pairing with another module is not independently additional, and an activity shall not be disaggregated so that a component made viable by the whole is presented as though it required support on its own. As a qualifying condition, each module for which additionality is claimed shall be technically viable and functional in the configuration as deployed. Only modules that are additional are credited. A module that is not additional is not credited, and each other module remains eligible where it is additional with that module present.

6.1.3 | Additionality is assessed at validation and re-assessed at each crediting-period renewal (Section 6.8). The Investment Analysis uses data valid at the activity start date, in accordance with A6.4-AMT-002; regulatory surplus is assessed at validation and applies thereafter as set out in Section 6.3; common practice is assessed at the reference date of Section 6.6.1(a); and the renewal tests are assessed as at the date the renewal request is submitted.

6.1.4 | Micro-scale activities may instead follow the positive-list route of Section 6.2.

6.2 | Additionality Approach Selection

6.2.1 | Additionality under this methodology is demonstrated on a scale-proportionate basis:

a.| **Micro-scale activities (≤ 10,000 tCO_2e/yr, assessed on the Activity Cluster where Section 3.5 applies).** The activity may demonstrate additionality either through the full assessment (Sections 6.3–6.6) or by qualifying for the micro-scale Positive List (Annex 6). An activity on the Positive List is deemed to be financially additional and is not required to conduct the Investment Analysis (Section 6.5) or Common Practice Analysis (Section 6.6); it shall nonetheless satisfy the regulatory-surplus test (Section 6.3), and for combustion technologies, the lock-in test (Section 6.4). The Positive List and its eligibility criteria are established, and periodically reviewed (i.e., every three years from publication date), on the evidentiary basis set out in Annex 6. Where verified emission reductions of a micro-scale activity exceed 10,000 tCO_2e in a year, the reductions claimed for that year are capped in accordance with the GHG Emissions Reductions & Sequestration Product Requirements (Section 9).

b.| **Small- and large-scale activities.** The Positive List is not available for small- or large-scale activities. The activity shall demonstrate regulatory surplus (Section 6.3), lock-in risk where applicable (Section 6.4), financial additionality through the Investment Analysis (Section

6.5), and common practice (Section 6.6), subject to the exemption of Section 6.6.1(h).

c.| **Virtual Power Plants (Module VPP).** Additionality, common practice and scale are assessed at the aggregator/platform level, across the Digital Aggregation Perimeter, not at the individual household or asset level. Where the aggregated activity is micro-scale, the Positive List route is available at the platform level.

6.3 | Regulatory Surplus Analysis

6.3.1 | The activity developer shall demonstrate that the reductions are surplus to regulation:

a.| The activity type is not excluded by any publicly available negative list declared by the host Party for Article 6 participation. Where no such list exists, the activity is assumed not to be excluded.

b.| The activity is not mandated by any existing or pending law[1], statute, regulation, standard or legal requirement in the host Party, and there is no legal obligation to deploy the technology or to achieve the emission performance the activity delivers.

c.| The existence of a support scheme (e.g., feed-in tariff, renewable portfolio standard, tax credit, auction or tender) is not in itself disqualifying, but shall be fully reflected in the Investment Analysis (Section 6.5). An activity implemented under a binding legal obligation, or under a competitive support scheme whose award is conditioned on delivering a defined capacity or generation target (for example, a capacity auction with a binding delivery commitment), does not meet regulatory surplus; a non-binding or price-support scheme open to all comers does not, of itself, defeat it.

6.3.2 | This test shall be conducted at validation and at each renewal. Crediting ceases on the date a new relevant legal requirement mandating the activity enters into force. Cessation has prospective effect only: emission reductions verified for periods completed before that date, and units validly issued, are unaffected.

6.4 | Lock-In Risk Analysis (Mandatory for All Modules)

6.4.1 | The activity developer shall assess whether the activity may lead to a lock-in of GHG emissions, technologies, or carbon-intensive practices inconsistent with the Paris Agreement's long-term goals.

a.| **Zero-Emission generation and storage, run-of-river hydropower and geothermal:** Activities deploying solar, wind, run-of-river

[1] A **pending law** means a legal instrument that has been formally adopted or tabled by the competent authority and has a defined entry-into-force date but is not yet in force; an instrument merely under discussion, without formal adoption or a defined commencement, is not a pending law for this purpose.

hydropower, marine, geothermal or storage are not interchangeable with, or co-fireable alongside, fossil generation and do not create fossil lock-in; a quantitative lock-in assessment is not required. Compliance with the applicability conditions and technology-specific safeguards (Section 3.2) demonstrates conformance. Geothermal non-condensable-gas and working-fluid emissions are captured as activity emissions (Section 8).

b.| **Combustion technologies (biomass, biogas, landfill gas) and reservoir hydropower :** The power-generation component of biomass, biogas and landfill-gas activities, and reservoir hydropower activities shall undergo a quantitative lock-in risk assessment comparing the activity's lifecycle emission intensity against the host country's LT-LEDS, using the GS4GG Methodology Tool: Analysis of Lock-in Risk (MT400-09, Section 4).

6.5 | Investment Analysis

6.5.1 | The activity developer shall conduct the Investment Analysis in accordance with A6.4-AMT-002 (latest valid version), and shall demonstrate whichever analysis option is used, that without carbon revenue the activity does not reach the financial benchmark and, where an investment comparison is used, is not the most attractive alternative; and that with carbon revenue it reaches the benchmark (A6.4-AMT-002, paragraphs 31 and 34). Where several modules are deployed, Section 6.7 applies. This methodology does not restate the tool's requirements; it specifies only the following methodology-specific provisions.

a.| **Real terms.** Cash flows shall be modelled in real terms, with inflation applied consistently to all cash-flow lines and the discount rate stated on a consistent basis. Where cash flows arise in more than one currency, they shall be converted into the currency of the financial benchmark at the exchange rate prevailing at the decision making date and held constant in real terms.

b.| **Mature-technology benchmark.** For mature, widely deployed technologies (in particular utility-scale solar photovoltaic and onshore wind), the analysis shall be corroborated against independent market evidence, recent auction or power-purchase-agreement prices and published sectoral cost data for the host market, and shall demonstrate that the economic performance of the activity increases decisively through carbon credit revenues, and that these revenues raise the financial indicator to or above the required financial benchmark, rather than resting on assumption choices alone. Where independent evidence indicates the technology is deployed at scale without carbon revenue in the host market, a favourable Investment Analysis based on activity-specific assumptions is not, by itself, sufficient**.**

i. **Evidence hierarchy:** Corroborating market evidence shall be drawn, in descending order of preference, from: concluded

competitive procurement results in the host market; executed power-purchase-agreement prices reported by the regulator or system operator; published sectoral cost benchmarks for the host market from recognised independent sources. Older than three-year-old evidence shall not be used where more recent evidence exists.

ii. **Deployment at scale:** Deployment at scale means observed deployment in the host market whose measurement follows the conventions of Section 6.6 (indicator, geographical area); the assessment is evidential and does not import the Section 6.6 threshold.

iii. **Recent competitive prices:** Where the technology has been contracted in the host market through a competitive process without carbon revenue within the three years before the reference date of Section 6.6.1(a), the Investment Analysis shall use the most recent clearing price as the electricity price, adjusted only for documented differences in site, size and grid connection. If the activity reaches the financial benchmark at that price, it is not additional. Where no such process has concluded in that period, the evidence hierarchy applies.

c.| **Module-specific application**:

i. ***Module GG (Greenfield)***: benchmark analysis (activity IRR against a recognised sectoral benchmark) or comparison against the realistic alternative generation investment.

ii. ***Module BO (Brownfield)***: investment comparison on the incremental cash flows of the optimisation or repowering investment relative to the continued operation of the existing asset.

iii. ***Module ST (Storage)***: investment comparison or benchmark on the storage asset's economics, reflecting realistic energy-arbitrage and flexibility revenues.

iv. ***Module CG (Captive)***: investment comparison against continued captive fossil generation or grid import. The analysis perspective is the investment decision in the generation (and any storage) asset. Where the asset is owned and financed by a party other than the consumer (independent power producer or energy-service structures), benchmark analysis in accordance with A6.4-AMT-002 is permitted, applied to the asset owner's investment; the consumer's electricity-cost saving is not the assessed investment.

v. ***Module VPP***: investment analysis is conducted at the Aggregator/Platform level (including platform, telemetry, customer acquisition, and operational costs) against aggregated wholesale, ancillary and flexibility revenues, not at the individual DER asset level.

6.5.2 | **Assumptions:** Realistic, documented and conservative inputs for capital cost, operating cost (including energy prices), output and electricity prices and discount rate. Carbon revenue is excluded to establish pre-carbon viability.

6.5.3 | **Sensitivity.** A sensitivity analysis is performed in accordance with A6.4-AMT-002. As permitted by paragraph 68(b) of that tool, this methodology specifies that:

a.| cash-flow inputs shall be aggregated by category (all capital costs, all operating costs, and all revenues each treated as a single input) before the materiality test is applied, so that a category cannot be split into sub-components to fall below the tool's threshold;

b.| each input constituting more than 20 per cent of total costs or total revenues shall be varied by at least ±10 per cent, and the material inputs shall also be varied in combination, not only individually, so that plausible concurrent errors are tested; and

c.| in accordance with paragraph 69 of A6.4-AMT-002, where any such variation causes the financial indicator to reach the benchmark or the activity to become the most financially attractive option, the activity is not additional.

6.6 | Common Practice Analysis:

6.6.1 | The activity developer shall conduct a common-practice analysis in accordance with GS4GG Methodology Tool: Common Practice Analysis (MT400-06), (latest version), for each module, as specified in this section. These provisions are deviations from MT400-06 expressly stated under the order of precedence (Section 2) and prevail over the tool to that extent.

a.| **Approach and reference date.** The analysis is stock-based. The reference date is the date on which the PDD is submitted to the VVB for validation and, at renewal, the date on which the renewal request is submitted. Data shall not be older than three years at the reference date. The activity's own capacity is excluded from both the similar and the total capacity.

b.| **Indicator:** Installed capacity (MW) as reported in the data sources of (e); for storage, rated discharge power.

c.| **Applicable geographical area (AGA):** The host country; where electricity supply is a state or provincial competence and the relevant grid is sub-national, that grid. Where the electricity system delineated for the activity under A6.4-AMT-007 is transboundary, the applicable geographical area is that electricity system.

d.| **Total capacity (P_{all}).** The installed capacity of all generation and storage in the applicable geographical area, including captive capacity where official statistics report it. The same total applies to every module.

e.| **Similar capacity (P_{sim}).** The installed capacity of activities in the same technology class and supply configuration as the module (Table 6.3). Captive supply is supply behind the consumer's meter or over a dedicated line; supply over the public network, including wheeling, open access and virtual or financial power-purchase agreements, is grid-connected supply. Capacity in the captive or aggregated configuration shall be taken from official statistics or recognised sources (the regulator, the system operator, the responsible ministry or IRENA). Where those data do not separate the configuration, the similar capacity is the installed capacity of the technology class in all configurations and, for a VPP, the installed capacity of all behind-the-meter solar PV and storage

f.| **Exclusions.** Activities registered or applying under any crediting mechanism (GS4GG, Article 6.4, CDM or other schemes), and activities for which grants or concessional finance from official development assistance or international climate finance dedicated to mitigation cover more than half of the capital cost, are excluded from the similar capacity only.

g.| **Threshold.** $F = P_{sim} / P_{all}$ is calculated per MT400-06. F_{max} is 10% for every technology and module, irrespective of technology maturity or the classification of the host country. Where $F \geq F_{max}$, the module is common practice and is not additional. No technology is classified under MT400-06 Section 7.6, and Section 5.4 of the tool does not apply.

h.| **Exemption.** A module of an activity located in a Least Developed Country or Small Island Developing State is exempt from the common-practice analysis where the installed capacity of the activity, all modules together and for solar PV the DC rating, is up to 5 MW, assessed on the Activity Cluster where Section 3.5 applies. LDC or SIDS status is that on the United Nations lists at the reference date. The exemption covers the common-practice analysis only; regulatory surplus, lock-in where applicable and the Investment Analysis apply in full.

i.| **Modularity.** Each module is tested in its own technology class and supply configuration. A module that is common practice does not render the activity's other modules ineligible.

j.| **Renewal.** The analysis, including the exemption, is re-performed at each renewal (Section 6.8).

Table 6.3. Attribute Matrix for the Common Practice Analysis

Attribute	Classes treated as distinct	Required for similarity

Technology class	Solar PV; concentrating solar thermal; onshore wind; offshore wind; run-of-river hydropower; reservoir hydropower (Section 3.2.4(a)); geothermal; marine (wave, tidal); solid biomass; biogas and landfill gas; battery storage; pumped hydro storage; other mechanical or thermal storage; VPP platform	Yes
Supply configuration	Grid-connected supply; captive supply; aggregated distributed resources (VPP)	Yes
Capacity or output	None	No

6.7 | Integrated Solutions

6.7.1 | Where two or more modules are co-located and validated together as an Integrated Solution, the Investment Analysis is conducted for each module separately where the modules could be implemented separately in the same manner without affecting each other, and for the modules together only where they could not (A6.4-AMT-002, paragraph 17); the activity developer shall document why they could not. A combined analysis is not available where any module, on its own attributable cash flows (Section 6.7.2), reaches the financial benchmark without carbon revenue; that module is not additional. A combined Investment Analysis does not waive the module-level demonstration of regulatory surplus, lock-in (where applicable) or common practice, nor the boundary-delineation and double-counting rules (Sections 5.1 and 11.3). Regulatory surplus is demonstrated for each module and for the combination. Consistent with Section 6.1, each module is assessed on the basis that the other co-located modules are present, and the activity shall not be split so that a component viable only in combination is presented as additional on its own.

6.7.2 | Any shared capital or operational expenditure between co-located modules shall be pro-rated on a transparent, documented basis (for example, by capacity, energy throughput or a directly attributable-cost allocation), and all synergies (for example, avoided-curtailment revenue captured by a co-located battery) shall be fully reflected in the relevant module's cash flow.

6.7.3 | A module added after validation is not a phased expansion of the existing activity; it is registered as a co-located new activity or VPA with its own crediting period, additionality demonstration and baseline (Section 3.1).

6.8 | Ongoing Financial need (OFN)

6.8.1 | At each crediting-period renewal, the activity developer shall demonstrate ongoing financial need by satisfying:

a.| **Regulatory surplus** (mandatory; Section 6.3);

b.| **Financial Viability Analysis**, in accordance with Section 7 of the GS4GG Requirements for Additionality Demonstration. The analysis is forward-looking over the renewed crediting period. It shall be conducted on the same financial-analysis option, financial indicator and cash-flow basis used at the first crediting period; the assumptions shall be updated. Realised values, including metered generation, realised tariffs and prices, actual operating and maintenance costs and carbon revenues received, are the mandatory evidence base for the updated assumptions wherever they exist; forward assumptions shall be reconciled to them, and any departure shall be justified against independent sources (published forecasts of the system operator, the regulator or recognised independent analysts) using a conservative range with sensitivity analysis. Historical performance informs the updated assumptions and is not a separate backward test. The analysis shall demonstrate that carbon revenue remains necessary for the activity itself to remain operational and viable in the renewed period, assessed on the activity's operating economics irrespective of any change in ownership[2], taking account of all carbon and non-carbon revenues; and

c.| **Common practice**, re-performed for the prevailing market (Section 6.6) as in force at renewal, on current market data, applying the same indicator and measurement basis as Section 6.6.1; the consequence of a common-practice finding at renewal is governed by Section 6.8.2 and Section 17.

6.8.2 | Where the activity would be viable against its applicable benchmark without carbon revenue, the crediting period shall not be renewed. Persistent ongoing financial need does not, in itself, exempt the activity from the common-practice re-assessment. The full renewal procedure is set out in Section 17.

6.8.3 | Renewal does not reopen Section 6.5. The Investment Analysis of Section 6.5 remains valid for the first crediting period only. At each renewal the activity applies this Section 6.8, comprising the regulatory-surplus re-assessment (Section 6.3), the Financial Viability Analysis under (b), and the common-practice re-assessment under (c). The original additionality determination is not retrospectively reassessed; realised data update the forward-looking analysis and do not overturn the determination made for a completed crediting period (Section 17).

6.8.4 | By way of exception to Section 6.8.1, an activity that relied on the Positive List (Section 6.2) re-qualifies through the list at renewal where it remains micro-scale, assessed on the Activity Cluster (Section 3.5), and its activity type remains on the Positive List. It shall satisfy regulatory surplus (Section 6.3) and, for combustion technologies, the lock-in test (Section 6.4).

[2] Because the test is the activity's ongoing operating need rather than any individual owner's return, a capital-intensive activity whose capital costs are substantially recovered may not demonstrate ongoing financial need at renewal; this outcome is intended and conservative.

Otherwise it applies Section 6.8.1, with the Financial Viability Analysis established at renewal on a financial-analysis option permitted by A6.4-AMT-002.

7| BASELINE SCENARIO

7.1 | Baseline Determination (Stepwise Approach)

7.1.1 | The crediting baseline emissions shall be determined following the stepwise approach mandated by the *GS4GG Methodology Standard*: Requirements for Baseline Determination (PAA MS400-04), through the following five steps, applied independently for each Activity Module deployed:

a.| Step 1: Selection and Justification of the Baseline Approach;

b.| Step 2: Application of the selected approach prior to downward adjustment;

c.| Step 3: Application of the Downward Adjustment;

d.| Step 4: Identification of a conservative Business-As-Usual (BAU);

e.| Step 5: Comparison and selection of the final Crediting Baseline.

7.1.2 | All grid emission factors are determined under A6.4-AMT-007 (as modified by the GS4GG Grid-Emission-Factor Addendum) and all equipment lifetimes under A6.4-AMT-006, with GS4GG Technical Lifetime Addendum. The difference between the conservative BAU and the crediting baseline is quantified and reported (Section 7.6)

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

7.2.1 | In accordance with *Paragraph 36(c)* of the Article 6.4 Rules, Modalities and Procedures (RMPs) and *Section 8.4* of the *GS4GG Standard:* Requirements for Baseline Determination (PAA MS400-04), this methodology uses approach (c) - existing actual or historical emissions, adjusted downwards - for all modules.

7.2.2 | **Justification:**

a.| The mitigation outcome is the displacement of heterogeneous grid or captive fleet, not the production of a single comparable output: no single best-available-technology benchmark meaningfully represents the fleet displaced. Approach (c) is applied to two reference systems (a dual-reference architecture):

i. **Reference A** - the electricity system's existing/historical emissions, represented by the dynamic combined-margin (CM) or operating-margin (OM) grid emission factor determined under A6.4-AMT-007, for net-new generation and temporal shifting (Modules GG, ST, VPP and grid-connected module CG); or the captive fossil-fuel emission factor for the displacement of on-site captive fossil generation (Module CG).

ii. **Reference B -** the legacy asset's existing/historical generation, via the algorithmic Declining Baseline bounded by the asset's Remaining Useful Life, for brownfield asset optimisation (Module BO).

b.| Alignment with paragraph 33 (avoidance of over-crediting) is secured through ambition-based downward adjustment (Step 3) and reported through the conservative BAU comparison (Steps 4–5). The forward-looking ambition required by paragraph 33 is delivered by the downward adjustment.

7.3 | Step 2: Application of the Selected Approach

7.3.1 | **Identification of the baseline scenario:** The baseline scenario is the most plausible scenario in the absence of the activity, identified per module from the most recent three years of verifiable data at the time of submission to VVB for validation (Section 3.2). These scenarios are:

a.| **Modules GG (Greenfield) and ST (Storage):** the electricity delivered by the activity to the system would otherwise have been supplied by the existing grid-connected generation fleet and by new-build additions, as represented by A6.4-AMT-007.

b.| **Module BO (Brownfield):** the pre-existing asset continues to operate at its (already-degraded) historical level, declining with ageing, until the end of its RUL (A6.4-AMT-006), beyond which it would be decommissioned or replaced as business as usual.

c.| **Module CG:** the captive load would otherwise have been served by on-site fossil-fuel generation or by grid import.

d.| **Module VPP:** the aggregated distributed energy resources displace grid or marginal generation.

7.3.2 | **Suppressed demand is not applied:** the baseline reflects the electricity actually displaced (existing grid or captive generation), not a notional minimum service level (Section 3.2, Exclusions). An activity whose primary purpose is to serve previously unmet electricity demand (e.g., rural electrification) should apply a dedicated energy-access methodology.

7.3.3 | Binding legal requirements in force during the reference period are reflected; any portion of output that is legally required is excluded from crediting via $EG_{legal,y}$.

7.3.4 | **Calculation of the unadjusted baseline emissions:** The activity developer shall calculate the best – estimate unadjusted baseline emissions $(BE_{unadj,y})$ by summing the module outputs. The combined margin (operating + build) applies to net-new generation (Modules GG, BO, CG and VPP); the operating margin only, temporally resolved, applies to storage (Module ST).

7.3.5 | **Module GG: Greenfield**

$$BE_{GG,y} = EG_{PJ,y} \times EF_{grid,CM,y} \quad \text{(eq.1)}$$

$$EG_{PJ,y} = EG_{facility,y} - EG_{legal,y} \quad \text{(eq.2)}$$

Where

Parameter	Description
$BE_{GG,y}$	Module GG best-estimate baseline emissions in year y (tCO_2e)
$EG_{PJ,y}$	Net electricity supplied to the electricity system by the activity, creditable (net of any legally-required output) (MWh)
$EG_{facility,y}$	Net electricity supplied by the activity facility to the system, year y (MWh); monitored (Section 14)
$EG_{legal,y}$	Electricity the activity is legally required to generate/supply (MWh)
$EF_{grid,CM,y}$	Combined-margin grid emission factor (operating + build margin), year y (tCO_2/MWh), per A6.4-AMT-007.

7.3.6 | Module BO: Brownfield

$$EG_{baseline,BO,y} = (EG_{representative} \times (1+u) \times (1-d)^{(t_{op})} \quad [\text{For } t_{op} < RUL] \quad \text{(eq.3)}$$

$$EG_{baseline,BO,y} = 0 \ [\text{For } t_{op} \geq RUL] \quad \text{(eq.4)}$$

$$EG_{PJ,BO,y} = MAX[0, (EG_{facility,y} - EG_{baseline,BO,y})] \quad \text{(eq.5)}$$

$$BE_{BO,y} = EG_{PJ,BO,y} \times EF_{grid,CM,y} \quad \text{(eq.6)}$$

Where

Parameter	Description
$BE_{BO,y}$	Module BO best-estimate baseline emissions in year y (tCO_2e)
$EG_{baseline,BO,y}$	Declining historical baseline generation, year y (MWh)
$EG_{PJ,BO,y}$	Net incremental electricity credited to the activity, year y (MWh)
$EG_{facility,y}$	Net electricity supplied by the (repowered/optimised) facility to the system, year y (MWh); monitored
$EG_{representative}$	Net generation of the pre-existing asset in a representative recent operating year (MWh), reflecting the asset's accumulated degradation to date (Section 14). The representative recent operating year is established as the resource-normalised mean of the three most recent full operating years; where the inter-annual variability of the three resource-normalised values (the difference between the highest and the lowest, divided by their mean) exceeds 10 per cent, the higher of the mean and the median applies; the normalisation basis and data are documented in the PDD (Annex 1).

u	Fixed conservative uplift fraction applied to the representative baseline (replacing the historical standard deviation); Annex 1 default.
d	Standardised annual degradation rate of the technology (fraction); Annex default
t_{op}	Full operating years elapsed since the activity start date: zero in the first year of the crediting period, so that the baseline applies for exactly RUL years.
RUL	Remaining Useful Life in operating years, determined under A6.4-AMT-006
$EF_{grid,CM,y}$	Combined-margin grid emission factor, year y (tCO_2/MWh), A6.4-AMT-007, as modified by the GS4GG Technical addendum to the A6.4 Grid Emission Factor Tool.

7.3.7 | **Module ST: Storage (temporal operating margin)**

$$BE_{ST,y} = \sum_h \left(EG_{discharge,h,y} \times EF_{grid,OM,h,y}\right) \quad \text{(eq.7)}$$

Where

Parameter	Description
$BE_{ST,y}$	Module ST best-estimate baseline emissions in year y (tCO_2e)
$EG_{discharge,h,y}$	Net Electricity discharged by the storage asset in interval h (MWh)
$EF_{grid,OM,h,y}$	Operating-margin grid emission factor for interval h, under Tiered Temporal Accounting (Tier 2 hourly; or Tier 1 block × DF_{ToU})
DF_{ToU}	Tier-1 conservativeness discount (applied under Tier 1 only; Annex 2) (fraction)

7.3.8 | **Tiered Temporal Accounting assigns** $(EF_{grid,OM,h,y})$:

a.| Tier 2 (hourly operating margin, where the operator publishes or can supply the data); or

b.| **Tier 1 (Time-of-Use proxy):** Tier 1 (operating margin mapped to standardised load blocks, with the conservativeness discount DF_{ToU}), with the transition between tiers governed by the Grid-Emission-Factor Addendum (Section 3.2).

c.| Where the storage verifiably charges from co-located would-be-curtailed generation, the *charging* factor $EF_{grid,charge,hy}$ is zero (Section 8), subject to Annex 2.

7.3.9 | **Module CG: Captive**

$$BE_{CG,y} = EG_{displaced,y} \times EF_{baseline,CG,y} \quad \text{(eq.8)}$$

$$EF_{baseline,CG,y} = MIN\left(EF_{captive,fossil}, EF_{grid,CM,y}\right) \quad \text{[Grid connected facility]} \quad \text{(eq.9)}$$

$EF_{baseline,CG,y} = EF_{captive,fossil}$ [consumer displacing on-site captive fossil only] (eq.10)

Where the consumer draws simultaneously from a captive generator and the grid, the baseline emission factor is the single MIN (captive-fossil, grid) factor of eq. 9; no apportionment between the captive and grid factors is applied.

Where

Parameter	Description
$BE_{CG,y}$	Module CG best-estimate baseline emissions in year y (tCO_2e)
$EG_{displaced,y}$	Electricity from the captive renewable/storage assets displacing captive fossil generation or grid import, year y (MWh); monitored
$EF_{baseline,CG,y}$	Module CG baseline emission factor, year y (tCO_2/MWh)
$EF_{captive,fossil}$	Emission factor of the displaced captive fossil generation (tCO_2/MWh); from genset fuel and efficiency, or Annex conservative default

7.3.10 | **Module VPP: Virtual Power Plant**

$BE_{VPP,y} = BE_{VPP,gen,y} + BE_{VPP,\text{sto},y}$ (eq.11)

$BE_{VPP,gen,y} = EG_{agg,gen,y} \times EF_{grid,CM,y}$ [aggregated net-new distributed generation, Module GG approach] (eq. 12)

$BE_{VPP,\text{sto},y} = \sum_h EG_{agg,discharge,h,y} \times EF_{grid,OM,h,y}$ [aggregated storage flexibility, Module ST approach) (eq. 13)

Where

Parameter	Description
$BE_{VPP,y}$	Module VPP best-estimate baseline emissions in year y (tCO_2e)
$BE_{VPP,gen,y}$	VPP generation-component baseline (Module GG engine) (tCO_2e)
$BE_{VPP,\text{sto},y}$	VPP storage-component baseline (Module ST engine) (tCO_2e)
$EG_{agg,gen,y}$	Aggregated net-new distributed generation across the Digital Aggregation Perimeter (MWh)
$EG_{agg,discharge,h,y}$	Aggregated storage discharge across the perimeter in interval h (MWh)
$EF_{grid,CM,y}$	Combined-margin grid emission factor (tCO_2e /MWh)
$EF_{grid,OM,h,y}$	Operating-margin grid emission factor for interval h (tCO_2e /MWh)

7.3.11 | **Total unadjusted generation baseline**

$$BE_{gen,unadj,y} = \sum\left(BE_{GG,y} + BE_{BO,y} + BE_{CG,y} + BE_{VPP,gen,y}\right) \quad \text{(eq.14)}$$

Where

Parameter	Description
$BE_{gen,unadj,y}$	Total unadjusted generation baseline emissions, year y (tCO2e), summed over the generation modules actively deployed. Storage, Module ST (eq. 7) and the storage component of Module VPP (eq. 13), is excluded from the aggregate baseline and settled through the storage reconciliation of eq. 43.
$BE_{GG,y}$, $BE_{BO,y}$, $BE_{CG,y}$, $BE_{VPP,gen,y}$	Module-level unadjusted generation baseline emissions, summed over the modules actively deployed

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

7.4.1 | Two adjustments are applied to the best-estimate baseline, each once.

7.4.2 | **Uncertainty adjustment:** Consistent with MS400-04 6.3.1.5(b)(i), uncertainty is addressed by applying conservative values to individual parameters, with the degree of conservativeness inversely proportional to demonstrated data quality. The module baselines (eq. 1–13) are evaluated with each parameter at its conservative bound: the grid emission factor at the Case-2 lower bound of A6.4-AMT-007 (Table 4 / 102), default parameters at their conservative Annex 1 values. No separate aggregate error-propagation deduction is applied; the identity reflects that conservativeness is applied at parameter selection:

$$BE_{gen,unc,y} = BE_{gen,unadj,y} \quad \text{(eq.15)}$$

7.4.3 | **Adjustment for Ambition (DAF):** The applicable Downward Adjustment Factor (DAF) to account for ambition adjustment, sourced by cross-reference from the GS4GG DAF Determination Tool (PAA MT400-05), is applied.

$$BE_{gen,adj,y} = BE_{gen,unc,y} \times \left(1 - DAF_y\right) \quad \text{(eq.16)}$$

Where

Parameter	Description
$BE_{gen,unc,y}$	Uncertainty-adjusted (parameter-conservative) baseline in year y (tCO_2e), applied once to the generation aggregate.
DAF_y	Downward Adjustment Factor for year y (fraction), (PAA MT400-05)
$BE_{gen,adj,y}$	Ambition-adjusted baseline in year y (tCO_2e), from eq 16

7.5 | Step 4: Identification of the Conservative BAU Scenario

7.5.1 | The conservative BAU baseline is the emissions of the generation displaced by the activity, deemed identical to the baseline scenario and quantified with the dynamic A6.4-AMT-007 factor without ambition adjustment:

$$BE_{gen,BAU,y} = BE_{gen,adj,UNC,y} \quad \text{(eq.17)}$$

Where

Parameter	Description
$BE_{gen,BAU,y}$	Conservative Business-as-Usual baseline emissions in year y (the uncertainty-adjusted generation baseline without the ambition adjustment) (tCO_2e).

7.6 | Step 5: Comparison and Selection of the Crediting Baseline

7.6.1 | The Crediting Baseline is the lower of the Downward-Adjusted Baseline (Step 3) or the Conservative BAU Baseline (Step 4). Because the DAF continually lowers the baseline, the crediting baseline shall be:

$$BE_{gen,y} = min(BE_{gen,adj,y}, BE_{gen,BAU,y}) \times CF_y \quad \text{(eq.18)}$$

Where

Parameter	Description
$BE_{gen,y}$	Crediting baseline generation emissions in year y (tCO_2e).
$BE_{gen,adj,y}$	Downward-adjusted generation baseline emissions, year y (tCO_2e)
CF_y	Crediting factor (default 1) (Fraction)

7.6.2 | Because $BE_{gen,adj,y} = BE_{gen,unadj,y} \times (1 - DAF_y) \leq BE_{gen,BAU,y}$ in every year and the crediting baseline resolves to the ambition-adjusted baseline; Steps 4 and 5 constitute the transparency and verification report of section 7.6, not an independent binding selection (tCO_2e).

7.7 | Quantification of the Difference between BAU and Crediting Baseline.

7.7.1 | As required by MS400-04, the difference between the conservative BAU emissions and the Crediting Baseline Emissions shall be quantified and reported transparently in each monitoring report.

$$\Delta_y = \Delta_{gen,y} + \Delta_{sto,y} \quad \text{(eq.19)}$$

$$\Delta_{gen,y} = BE_{gen,BAU,y} - BE_{gen,y} = BE_{unc,y} \times DAF_y \quad \text{(eq.19a.)}$$

$$\Delta_{sto,y} = \sum_h [EG_{discharge,h,y} \times EF_{grid,OM,h,y} \times DAF_y] \quad \text{(eq.19b.)}$$

Where

Parameter	Description

Δ_y	Emissions excluded from crediting through the ambition mechanism, the activity's uncredited contribution to the host Party's NDC (RMP section 33) (tCO_2), being the generation ambition margin plus the ambition foregone on the storage discharge side.

8| ACTIVITY EMISSIONS

8.1 | Identification of Activity Scenario

8.1.1 | Activity emissions ($AE_{,y}$) represent the aggregate direct and indirect greenhouse gas (GHG) emissions occurring within the spatial boundary during the monitoring period as a direct result of the implementation and operation of the activity.

8.2 | Calculation of Total Activity Emissions

8.2.1 | Activity emissions (AE_y) shall be the sum of the applicable sub-components; each term is included only where the corresponding module and technology are present (for a standalone greenfield wind farm, $AE_y = 0$):

$$AE_y = AE_{fc,y} + AE_{gp,y} + AE_{hp,y} + AE_{aux,y} + AE_{charge,y} + AE_{fss,y} \quad \text{(eq.20)}$$

Where

Parameter	Description
AE_y	Total activity emissions in year y. tCO_2e/yr; a reporting total (the ER calculation in 10 uses the disaggregated form) (tCO_2e)
$AE_{fc,y}$	Fossil-fuel combustion - ignition, start-up, emergency backup, offshore O&M (tCO_2e)
$AE_{gp,y}$	Geothermal operation — non-condensable gases and working fluid (tCO_2e)
$AE_{hp,y}$	Reservoir CH_4 of hydropower/PHS (tCO_2e)
$AE_{aux,y}$	Auxiliary grid-electricity consumption by the generation plant (tCO_2e)
$AE_{charge,y}$	Grid electricity imported to charge storage / pump PHS (tCO_2e)
$AE_{fss,y}$	Release of agents from BESS fire-suppression systems (tCO_2e)

Biogenic CO_2 and the methane-destruction outcome of biomass/biogas/LFG plants fall under the Accompanying Methodology (3.1) and are not quantified here; only the fossil fuel these plants combust for ignition, start-up and backup operation is captured under $AE_{fc,y}$.

8.3 | Fossil-fuel combustion

$$AE_{fc,y} = \sum_i \left(FC_{i,y} \times COEF_{i,y}\right) \quad \text{(eq.21)}$$

$$COEF_{i,y} = NCV_{i,y} \times EF_{CO2,i,y} \times 1.002 \quad \text{(eq.22)}$$

Where

Parameter	Description
$FC_{i,y}$	Quantity of fossil fuel type i combusted, year y (mass or volume) (t/m³/litres)
$COEF_{i,y}$	CO_2e emission coefficient of fuel type i, inclusive of non-CO_2 (tCO_2e per unit)
$NCV_{i,y}$	Net calorific value of fuel type i (GJ per unit)
$EF_{CO2,i,y}$	CO_2 emission factor of fuel type i (tCO_2/GJ)
1.002	Factor accounting for CH_4 and N_2O combustion emissions to the CO_2-only factor (dimensionless)

8.3.1 | Fossil fuel emissions are calculated with eq. 21 and eq. 22 from the measured fuel quantity [GR-M09]. O&M fuel (including transport) is included where metered and material (≥ the 1% threshold of Section 5.2), applied consistently across technologies.

8.3.2 | **Fossil-fuel conditions (mandatory, all modules):** The conditions of Section 3.2.4(b)(i) and (ii) apply to every activity that combusts fossil fuel within the activity boundary, whatever the module. They are tested for each calendar month m of the crediting period. A part-month at the start or end of the crediting period is combined with the adjacent calendar month.

a.| **Fossil-fuel cap:** Electricity derived from fossil fuel shall not exceed τ of the activity's electricity generation in the month, as calculated with eq. 23 and eq. 24. $FC_{cap,i,m}$ comprises all fossil fuel combusted for ignition and start-up and for backup operation in month m. Fuel combusted by backup generators during a period of officially declared disaster or system outage is excluded: it is deducted under eq. 21 but not counted towards the cap. A month in which fuel counted towards the cap is combusted and no electricity is generated fails the cap.

$$f_{fossil,m} = E_{fossil,m}/EG_m \leq \tau \qquad \text{(eq 23)}$$

$$E_{fossil,m} = \sum_i (FC_{cap,i,m} \times NCV_{i,y} \times \eta_{gen}) \div 3.6 \qquad \text{(eq 24)}$$

Where

Parameter	Description
$f_{fossil,m}$	Share of the activity's electricity generation derived from fossil-fuel in calendar month m
$E_{fossil,m}$	Electricity generated from fossil-fuel combustion (ignition, start-up, emergency backup), in month m (MWh)
EG_m	Total electricity generated by the activity in interval z (MWh); Exceedance voids the month only, not the monitoring period.

$FC_{cap,i,m}$	Quantity of fossil fuel type i counted towards the cap in month m (mass or volume unit)
$NCV_{i,y}$	Net calorific value of fuel type i (GJ per unit)
η_{gen}	Design or measured net electrical efficiency of the unit in which the fuel is combusted (fraction)
τ	Fossil-fuel cap, 5%
m	Calendar month of the crediting period
3.6	Unit conversion (GJ per MWh)

b.| **Co-firing traceability:** All fossil fuel combusted in month m shall be attributable, from the timestamped operating records, to an ignition and start-up sequence or to backup operation. Fossil fuel that is not so attributable is co-firing, and the month fails this condition.

c.| **Backup limit:** Backup operating hours are counted cumulatively through each calendar year from the timestamped operating records, excluding periods of officially declared disaster or system outage. A month in which counted backup operation occurs after the 100th counted operating hour of that calendar year fails this condition.

d.| **Consequence**: A month that fails (a), (b) or (c) is a non-conforming month. Its electricity generated, exported and discharged is set to zero in the calculation of baseline emissions, as for a data gap under the Conservative Replacement Rule of Annex 4. Activity emissions, including fossil-fuel emissions (eq. 21), and leakage remain deducted in full. Any resulting deficit is carried forward under Section 10.1. All other months are credited in full, and a non-conforming month does not affect the eligibility of the activity.

e.| **Records**: Fossil fuel is measured and recorded at least monthly by purpose: ignition and start-up; backup operation; and backup operation during officially declared disaster or system outage. Monthly quantities are reconciled annually against fuel purchases and stock changes. Each fossil-fuelled unit keeps timestamped operating records of burner light-off, synchronisation, attainment of minimum stable generation and shut-down, and of backup start and stop. A declared disaster is evidenced by the declaring authority’s notice, and a system outage by system-operator or utility records.

f.| **Missing records**: Missing fuel data are set to their maximum plausible value under the Conservative Replacement Rule of Annex 4. Fuel that cannot be attributed under (b) because operating records are missing is treated as co-firing

8.4 | Geothermal Fugitive Emissions:

8.4.1 | For dry, flash steam or binary geothermal plants, fugitive CO_2 and CH_4 from non-condensable gases (and working-fluid leakage for binary plants) shall be quantified. All non-condensable gas entering a dry/flash plant is conservatively assumed vented; well-testing/bleeding emissions are excluded as negligible.

$$AE_{gp,y,(dry/flash)} = AE_{stream,y} \quad \text{(eq.25)}$$

$$AE_{gp,y,(binary)} = AE_{stream,y} + AE_{workingfluid,y} \quad \text{(eq.26)}$$

$$AE_{stream,y} = \left(\omega_{steam,CO2,y} + \left(\omega_{steam,CH4,y} \times GWP_{CH4}\right)\right) \times M_{steam,y} \times \left(1 - r_{reinj,y}\right) \quad \text{(eq.27)}$$

$$AE_{workingfluid,y} = M_{workingfluid,y} \times GWP_{workingfluid,y} \quad \text{(eq.28)}$$

Where

Parameter	Description
$AE_{gp,y}$	Geothermal fugitive activity emissions in year y (tCO_2e)
$AE_{stream,y}$	Steam-borne non-condensable-gas emissions (CO_2 + CH_4) (tCO_2e)
$AE_{workingfluid,y}$	Working-fluid leakage emissions (binary plants) (tCO_2e)
$\omega_{steam,CO2,y}$	Mass fraction of CO_2 in the geothermal steam, year y (tCO_2/t steam)
$\omega_{steam,CH4,y}$	Average mass fraction of CH_4 in produced steam, year y (t/t steam)
$M_{steam,y}$	Mass of geothermal steam produced in year y (t steam)
$r_{reinj,y}$	Verifiably reinjected and metered fraction of non-condensable gas (zero unless demonstrated) (fraction)
$M_{workingfluid,y}$	Mass of working fluid lost (binary plants), year y (t)
GWP_{CH4}	Global warming potential of CH_4 (AR5, 100-yr; operative value in Section 14) (tCO_2e/t)
$GWP_{workingfluid,}$	Global warming potential of the working fluid (AR5; 100-yr; operative value in section 14 & Annex 1) (tCO_2e/t)

8.5 | Hydropower/PHS Reservoir Emissions

8.5.1 | Activities resulting in new reservoirs or the physical volumetric expansion of existing reservoirs shall calculate biogenic reservoir emissions based on the Power Density (PD).

$$AE_{hp,y} = 0 \quad \text{[For PD > 10 W/m²]} \quad \text{(eq.29)}$$

$$AE_{hp,y} = \frac{\left(EF_{res} \times TEG_y\right)}{1000} \quad \text{[For 4 < PD ≤ 10 W/m²]} \quad \text{(eq.30)}$$

Where

Parameter	Description
$AE_{hp,y}$	Reservoir activity emissions in year y (tCO_2e)
EF_{res}	Default reservoir emission factor ($kgCO_2e/MWh$)
TEG_y	Total electricity produced by the activity, including internal loads, year y (MWh)
PD	Power density of the reservoir (W/m^2). *For activities expanding existing reservoirs, PD shall be calculated on an incremental basis:* $PD = \frac{CAP_{AJ} - CAP_{BL}}{A_{AJ} - A_{BL}}$ *where CAP is the installed capacity (W) and A is the reservoir surface area (m^2) in the activity and baseline scenarios, respectively.*
1000	Unit conversion (kg → t) (kg/t)

For reservoir expansions, PD is computed on an incremental basis.

8.6 | Auxiliary grid consumption

$$AE_{aux,y} = EC_{aux,y} \times EF_{grid,upper,y} \quad \text{(eq.31)}$$

Where

Parameter	Description
$AE_{aux,y}$	Activity emissions from auxiliary grid consumption, in year y (zero where already netted within $EG_{facility,y}$ (tCO_2e)
$EC_{aux,y}$	Auxiliary grid electricity consumed by the generation plant, year y (MWh)
$EF_{grid,upper,y}$	Grid emission factor at the upper bound of its uncertainty interval, year y (tCO_2/MWh); Case 1 (tCO_2/MWh)

8.6.1 | Where auxiliary consumption is already netted within $EG_{facility,y}$, $AE_{aux,y} = 0$.

8.7 | Storage charging / PHS pumping

$$AE_{charge,y} = \sum_h \left(EC_{charge,h,y} \times EF_{grid,charge,h,y}\right) \quad \text{(eq.32)}$$

Where

Parameter	Description
$AE_{charge,y}$	Activity emissions from storage charging / PHS pumping, year y (tCO_2e)

$EC_{charge,h,y}$	Grid electricity imported to charge storage or pump water in PHS in interval h, year y (MWh)
$EF_{grid,charge,h,y}$	Charging emission factor in interval h, year y (tCO_2/MWh)

8.7.1 | Charging is metered gross (imported) and discharge (exported), capturing round-trip-efficiency losses; the two are reconciled via rolling carbon pool (Annex 2), floored at zero at the monitoring-period aggregate (Section 10.2).

8.8 | BESS fire-suppression agent release

8.8.1 | Zero where zero-/low-GWP agents (e.g., Novec 1230) are used. Where agents with GWP > 1 (e.g., HFC-227ea) are used:

$$AE_{fss,y} = \sum_e \left(M_{e,released,y} \times GWP_{agent}\right) \quad \text{(eq.33)}$$

Where

Parameter	Description
$M_{e,released,y}$	Mass of agent e released to atmosphere in year y (from activation logs / cylinder weighing; full charged mass assumed where undeterminable) (t)
GWP_{agent}	Global warming potential of the agent (AR5, 100-yr, tCO_2e/t agent)
e	Release events (fire, accidental discharge, leakage, malfunction, drills/testing)

9| LEAKAGE EMISSIONS

9.1 | Requirement

9.1.1 | In accordance with GS4GG PAA MS400-05, the activity developer shall identify all potential leakage sources, take reasonable and documented measures to minimise leakage (for example, sourcing lower-embodied-carbon hardware where an equivalent verified option is available, or siting to avoid land conversion and third-party wake effects) and quantify and deduct residual leakage. Where a source is not further minimised, the reason shall be recorded and the residual quantified in full.

9.2 | Step 1 - Identification of Leakage Emission Sources

9.2.1 | The following are potential sources of leakage per module:

a.| Baseline equipment transfer. Resolves to zero, under the Equipment Status rule, Section 3.2;

b.| Embodied emissions of activity hardware (mandatory, all modules);

c.| Wake / shadowing effects on an adjacent third-party wind or marine arrays; resource – use competition and rebound (excluded, conservatively, as immaterial);

d.| Land-use change (LUC) where land is converted.

9.3 | Step 2 - Minimisation of leakage

9.3.1 | The applicability conditions and safeguards minimise or eliminate several sources: the Equipment Status Rule resolves baseline equipment transfer to zero where replaced equipment is permanently decommissioned, and manages it through the double-counting safeguard of Section 3.2.1 where it is resold; the requirement for newly manufactured, additional generation (not diverted committed capacity) and the hydropower power-density and existing-reservoir conditions render resource competition immaterial; and the requirement that the activity supply electricity to the system without altering the level of service renders diversion / rebound immaterial. These two sources are therefore excluded for simplification, conservatively.

9.4 | Step 3 - Quantification of leakage

9.4.1 | The remaining sources of leakage emissions shall be quantified as follows:

$$LE_y = LE_{embodied,y} + LE_{wake,y} + LE_{LUC,y} \quad \text{(eq.34)},$$

Where

Parameter	Description
LE_y	Total leakage emissions in year y. (tCO_2e)
$LE_{embodied,y}$	Embodied emissions of activity hardware deducted in year y (eq. 35) (tCO_2e)
$LE_{wake,y}$	Wake/shadowing leakage on adjacent third-party plants, year y (tCO_2e); zero unless applicable
$LE_{LUC,y}$	Land-use-change leakage, year y (tCO_2e); zero unless land is converted

9.4.2 | **Embodied Emissions ($LE_{Embodied,y}$):** Applicable to All Modules. This methodology accounts for the GHG emissions from the manufacture, transport and installation, and end-of-life of material-intensive hardware (e.g., solar PV modules, wind turbines, BESS cells, wave and tidal converters), on the boundary of Annex 3, Section A 3.3.

9.4.3 | The total embodied footprint is amortised over N = MIN (technical lifetime, total crediting period i.e., maximum 15 years), so that it is fully recovered within the crediting period (a precondition for claiming net reductions). Where the technical life or the crediting period is shorter, N follows the shorter value. As an alternative, the activity developer may deduct the full embodied emissions of a component at the first issuance that includes the component, subject to the deficit ledger of Section 10.1. The choice is the activity developer's, made for each component when it is validated or included, and is not changed thereafter:

$$LE_{Embodied,y} = LE_{Embodied,\text{gen},y} + LE_{Embodied,\text{sto},y} \quad \text{(eq.35)}$$

$$LE_{Embodied,\text{gen},y} = \sum_t \left(CAP_{gen,t} \times EF_{embodied,gen,t}\right) / \min(LT_t, L_{CP}) \quad \text{(eq.36)}$$

$$LE_{Embodied,\text{sto},y} = \sum_s \left[\left(Cap_s \times EF_{embodied,sto,s}\right) / \min(LT_s, L_{CP})\right] + \sum_s AUG\left[\left(Cap_{aug} \times EF_{cell/pack,s}\right) / MAX\left(1, L_{CP} - y_{aug} + 1\right)\right] \quad \text{(eq.37)}$$

Where

Parameter	Description
$LE_{Embodied,\text{gen},y}$	Embodied emissions of generation components deducted in year y (tCO_2e)
$LE_{Embodied,\text{sto},y}$	Embodied emissions of storage systems deducted in year y (tCO_2e)
t	Generation component, by technology class (Annex 1, Section A 1.4)
$Cap_{gen,t}$	Installed capacity of generation component t (MW): the rated DC power of the installed modules at standard test conditions (MWp) for solar PV; the AC nameplate capacity for other technologies. Under Module BO, the capacity of new or replaced generating equipment only
$EF_{embodied,gen,t}$	Embodied emission factor of the technology class of component t (tCO_2e/MW, numerically equal to kg CO_2e/kW): Annex 1, Section A 1.4, or an activity-specific value under Annex 3, Section A 3.9
LT_t, LT_s	Technical lifetime of generation component t or storage system s (years), per A6.4-AMT-006
L_{CP}	Maximum aggregate crediting period (years, ≤ 15), irrespective of intermediate renewal cycles; for a technology included at a later stage, the remaining period of the crediting period
$Cap_s.$	Installed capacity of storage system s: energy capacity (MWh) for electrochemical storage; installed turbine capacity (MW) for pumped hydro storage
Cap_{aug}	Installed energy capacity of an augmentation (MWh)
$EF_{embodied,sto,s}$	Embodied emission factor of storage system s: tCO_2e/MWh installed for electrochemical storage; tCO_2e/MW of turbine capacity for pumped hydro storage; Annex 1, Section A 1.5
$EF_{cell/pack,s}$	Cell/pack-only embodied factor for augmentations (tCO_2e/MWh), excluding balance of plant; not applicable to pumped hydro storage
y_{aug}	Year of the crediting period in which the augmentation occurs

No unit-conversion factor applies: MW × tCO_2e/MW and MWh × tCO_2e/MWh give tCO_2e.

Generation embodied (eq 36) are a fixed total set by installed capacity at commissioning and amortised linearly over N, independent of actual output. Storage embodied emissions (eq. 37) are amortised in the same way. Capacity augmentations use the cell/pack factor only, excluding balance of plant, and are amortised over the remaining crediting-period years, MAX (1, L_{CP} − y_{aug} + 1). The deficit ledger of Section 10.1 ensures that no deduction is extinguished by the annual floor.

9.4.4 | **Wake / shadowing effects ($LE_{wake,y}$):** Applicable to Wind and Marine Power. If new turbines/converters reduce the kinetic energy yield of an adjacent, pre-existing third-party renewable energy farm located within 5 km (for onshore arrays) or 100 km (for offshore arrays), the lost generation in adjacent generation shall be translated into displaced grid emissions and deducted as Leakage. The modelled wake generation loss ($EG_{wake,y}$) shall be increased by 50 per cent before conversion to leakage, as a conservativeness margin for far-field model uncertainty. The margin does not apply where the loss is established by metered before-and-after measurement of the affected array agreed with its operator.

$$LE_{wake,y} = EG_{wake,y} \times EF_{grid,CM,y} \qquad \text{(eq.38)}$$

Where

Parameter	Description
$\boldsymbol{EG_{wake,y}}$	Reduction in net generation of adjacent third-party plants attributable to the activity's wake, year y (MWh); from an EIA or wake study
$\boldsymbol{EF_{grid,CM,y}}$	Combined-margin grid emission factor, year y (tCO_2/MWh), per A6.4-AMT-007

The wake assessment is required where a third-party array lies within 5 km (onshore) or 100 km (offshore) of the activity; beyond these distances the effect is deemed negligible and $\boldsymbol{LE_{wake,y} = 0}$. Where the affected plant is itself a registered crediting activity, its loss is accounted within its own boundary and $\boldsymbol{LE_{wake,y}}$= 0 (to avoid double counting).

9.4.5 | **Land-use change** ($LE_{LUC,y}$)**:** Where the activity converts land, the resulting carbon-stock loss is amortised over 20 years per IPCC good-practice guidance. The carbon-stock calculation shall be documented with georeferenced parcel data and the sampling or default basis applied per pool, and shall be prepared by a suitably qualified expert (Section 3.4.1(d)).

$$LE_{LUC,y} = \frac{\Delta C_{LUC}}{T_{amor,lUC}} \qquad \text{(eq.39)}$$

$$\Delta C_{LUC} = MAX[\,0, (\sum_i (C_{bsl,i} - C_{act,i}) \times A_i \times \frac{44}{12})] \qquad \text{(eq.40)}$$

Where

Parameter	Description
$\boldsymbol{LE_{LUC,y}}$	Leakage from Land-use-change, year y (tCO_2e)
$\boldsymbol{\Delta C_{LUC}}$	Net carbon-stock loss from land conversion (floored at zero; apparent sequestration not credited) (tCO_2e)

$C_{bsl,i}$	Baseline carbon stock of pool/stratum i summed over the five IPCC pools (AGB, BGB, dead wood, litter, SOC)
$C_{act,i}$	Post-activity carbon stock of pool/stratum i (t C/ha), summed over the five IPCC pools (AGB, BGB, dead wood, litter, SOC)
A_i	Area of parcel i converted (ha)
$T_{amor,LUC}$	Amortisation period, fixed at 20 years (IPCC)
$\frac{44}{12}$	Conversion from t C to tCO_2

Note: Net-positive leakage (apparent sequestration) is not accounted. The MAX [0, …] operator in eq 40 floors ΔC_LUC at zero: where on-site vegetation (e.g., shrubs or trees around ground-mounted panels) would give $C_{act,i} > C_{bsl,i}$ and hence a mathematically negative (sequestration) value, it is set to zero and not credited as a reduction, such sequestration is outside the scope of this emission-reduction methodology.

9.4.6 | To avoid double counting, reservoir-related emissions from hydropower are accounted under Section 8.5 (reservoir CH_4) and are not also captured here.

9.5 | Leakage true-up on non-renewal or early cessation.

9.5.1 | Where embodied (eq. 35–37) and land-use-change (eq. 39-40) leakage are recovered by amortisation, the full leakage shall be recovered within the crediting period actually realised:

a.| **Trigger:** crediting period not renewed (developer's election or failed renewal re-assessment, Section 17.1), or the activity ceases verification / permanently terminates, before the amortised leakage is fully recovered.

b.| **True-up (final issuance):**The activity developer shall conduct a true-up calculation at the final issuance event of the crediting period. The remaining un-recovered embodied-leakage balance for the entire installed activity (all generation and storage capacity, including augmentations), together with any un-recovered land-use-change balance, shall be determined.

$LE_{true-up} = (LE_{embodied,total} + LE_{LUC,total}) - \sum already\ deducted$ for the entire installed activity, including augmentations (eq. 40.a).

c.| **Deduction:** $LE_{true-up}$ deducted in full from the final issuance, to prevent unrecovered carbon debt.

d.| **Shortfall:** Where the emission reductions of the final issuance are insufficient to absorb $LE_{true-up}$ in full the residual balance shall be reported to the Secretariat and settled in the following order:

i. deduction from any remaining issuance of the activity;

ii. cancellation of units held for the activity account;

iii. cancellation of an equivalent quantity of Gold Standard Paris-Agreement-aligned units of equivalent integrity from other activities, whether of the activity developer or of other developers, subject to Secretariat approval of the equivalence; units of other schemes, and Gold Standard units issued outside the PAA requirements, are not eligible; and

iv. only where (i) to (iii) do not settle the balance, cancellation of an equivalent quantity of units previously issued to the activity, as required by the Secretariat.

e.| **Running declaration**: At each issuance the activity developer shall declare the cumulative embodied (and land-use-change) leakage deducted and the outstanding balance, so the true-up amount is transparent and verifiable at any point.

Where:

Symbol	Description	Unit
$LE_{true-up}$	Un-recovered embodied and land-use-change leakage deducted at the final issuance	tCO_2e
$LE_{embodied,total}$; $LE_{LUC,total}$	Total embodied / land-use-change leakage to be recovered over the crediting period	tCO_2e

10| NET GHG EMISSION REDUCTIONS

10.1 | Calculation of Net GHG Emission Reductions

10.1.1 |Net reductions are the generation crediting baseline (from Section 7, already uncertainty- and ambition-adjusted) less activity emissions and leakage, with the Module ST storage arbitrage carved out into its own settlement reconciliation:

$$ER_{gross,y} = ER_{gen,y} + ER_{sto,y} - AE_{fss,y} - AE_{hp,PHS,y} - LE_y \quad \text{(eq.41)}$$

$$ER_y = MAX(0, ER_{gross,y} - D_{y-1}) \quad \text{(eq.41a)}$$

$$D_y = MAX(0, D_{y-1} - ER_{gross,y}) \quad \text{(eq.41b)}$$

Where activity emissions and leakage exceed baseline emissions in year y, the resulting deficit is carried forward and shall be cleared by emission reductions in subsequent years before any further reductions are credited. A net-emitting year is not extinguished by the annual zero floor.

$$ER_{gen,y} = BE_{gen,y} - AE_{gen,y} \quad \text{(eq.42)}$$

$$ER_{sto,y} = MAX(0, \sum_h [EG_{discharge,h,y} \times EF_{grid,OM,h,y} \times (1 - \text{DAF}_y) - EG_{discharge,h,y} \times EF_{grid,charge,attr,h,y} \div RTE]) \quad \text{(eq.43)}$$

Where

Parameter	Description
ER_y	Net emission reductions in year y (tCO_2e)
$ER_{gen,y}$	Net reductions from generation Modules GG, BO, CG and VPP (tCO_2e)
$ER_{sto,y}$	Net reductions from Module ST (monitoring-period reconciled) (tCO_2e)
$BE_{m\,x,y}$	Crediting baseline emissions for Module x in year y (tCO_2e), determined per Section 7)
$BE_{M5,gen,y}$	Crediting baseline emissions for Module VPP in year y (tCO_2e), determined per Section 7)
$AE_{gen,y}$	Activity emissions attributable to the generation modules in year y (tCO_2e)
$AE_{fss,y}$;	Fire-suppression emissions deducted at master level.
$EF_{grid,OM,h,y}$	Operating-margin grid emission factor for interval h (tCO_2/MWh)
$EF_{grid,charge,attr,h,y}$	Charging emission factor attributed to the energy discharged in interval h (tCO_2/MWh), via a dynamic energy-weighted rolling carbon pool (Annex 2)
RTE	Round-trip efficiency of the storage system (fraction); expresses charging emissions per unit discharged
$AE_{hp,PHS,y}$	Reservoir CH_4 of a pumped-hydro storage facility, where applicable (tCO_2e)
LE_y	Total leakage emissions, year y (tCO_2e)

10.1.2 | **Disaggregation rule (mandatory)**. $AE_{charge,y}$ is not deducted in $ER_{gen,y}$; it is captured exclusively inside the $ER_{M3,y}$ reconciliation through the $EF_{grid,charge,attr,h,y}/_{RTE}$ term. $AE_{fss,y}$ and, for pumped hydro, $AE_{hp,PHS,y}$ are storage-side activity emissions deducted at master level (eq 41). AE_y (eq 20) is a reporting total only and is not used directly in eq 41.

10.2 | Settlement-interval reconciliation and conservativeness floor (Module ST)

10.2.1 | The Module ST arbitrage is reconciled per interval and floored at zero only at the monitoring-period aggregate (eq. 43): perverse cycles offset emission-reducing cycles, so an asset whose net operation over the period increases system emissions earns zero. Charge-discharge attribution uses the energy-weighted rolling carbon pool of Annex 2, and the ambition adjustment applies to the discharge-displacement side only.

10.2.2 | The rolling-pool method, the curtailment evidentiary tests (including the physical would-be-curtailment standard for data-scarce grids), the A6.4-AMT-

007 build-margin override ($wBM = 0$) for storage, and, where storage charges from co-located generation, the anti-transmutation safeguard capping the discharge credit at the combined-margin value that generation would have earned as direct supply, are specified in Annex 2.

11| MEETING METHODOLOGICAL PRINCIPLES

11.1 | Encouraging ambition over time

11.1.1 |The crediting baseline is contracted by the ambition DAF (Section 7.4), aligning it with the host Party's net-zero / LT-LEDS trajectory; and for brownfield activities the Declining Baseline decays to zero at the end of the asset's Remaining Useful Life. The difference between the conservative business-as-usual baseline and the crediting baseline is quantified and reported each period as a transparency metric (Section 7.6).

11.2 | Equitable sharing of mitigation benefits

11.2.1 |Because the crediting baseline is set below the conservative BAU level, the uncredited difference accrues to the host Party's NDC. For long-lived assets, the 15-year maximum crediting period is materially shorter than the technical lifetime, so the host Party retains the substantial majority of the activity's lifetime mitigation beyond the crediting period.

11.3 | Avoidance of double counting

11.3.1 |The methodology includes explicit requirements to mitigate double issuance, double use and double claiming. Each megawatt-hour of credited generation or discharge gives rise to a single mitigation claim, evidenced by a single instrument and held by a single beneficiary. Cancellation of a unit or an environmental attribute extinguishes the claim it carries; where cancellation is effected on a named beneficiary's behalf, it assigns that single claim to the named beneficiary and extinguishes it for every other party. The same megawatt-hour shall not support more than one claim, whether as an issued unit, an environmental attribute or a Scope 2 reduction.

a.| **Energy attributes.** The electricity generated or discharged shall not be separately monetised or claimed under any other certification scheme or attribute market (RECs, I-RECs, guarantees of origin, green-hydrogen schemes, low-carbon fuel standards) unless the corresponding attributes are verifiably cancelled (retired in the relevant environmental-attribute or certificate registry so that the same MWh cannot be claimed elsewhere).

b.| **Mandatory schemes.** Where the activity or the displaced generation falls within a mandatory domestic scheme (e.g., an emissions trading system), the developer shall demonstrate no overlap, or cancel an equivalent quantity of allowances before issuance.

c.| **Accompanying methodologies.** Where applied in combination with an Accompanying Methodology (Sections 5.1, 11.3), the boundary shall be delineated so that no source, parameter or reduction is counted under both; biogenic CO_2 and methane-destruction outcomes are accounted only under the Accompanying Methodology.

d.| **Module stacking.** Within a single activity, electricity routed internally between modules is credited once (e.g., electricity from a Module GG plant charging a co-located Module ST battery is excluded from Module GG and credited only through the Module ST reconciliation).

e.| **Corporate / Scope 2.** The mitigation credited shall not also be claimed by an electricity off-taker, including a captive or contracted consumer supplied under Module CG (e.g., a group-captive or corporate-PPA arrangement) — as a Scope 2 reduction, nor monetised as a separate energy attribute (REC/GO), for the same megawatt-hours, unless the issued units (or attributes) are verifiably cancelled on the consumer's behalf in which case the single claim for those megawatt-hours vests in the consumer, and no unit is additionally issued or transferred for the same megawatt-hours

11.4 | Aligning with NDC and LT-LEDS

11.4.1 |The activity developer confirms the alignment with the host Party's latest NDC and shall demonstrate, through the ambition DAF and the below-BAU crediting baseline, a contribution consistent with the host Party's LT-LEDS and net-zero pathway. Where the host Party has authorised the units for international transfer, the corresponding adjustment applies.

11.5 | Encouraging broad participation

11.5.1 |The methodology is applicable globally, at micro, small and large scale— with proportionate provisions for micro-scale activities (the positive-list route, Section 6.2) and for activities up to 5 MW in Least Developed Countries and Small Island Developing States (the common-practice exemption, Section 6.6.1(h)). across five selectable, combinable modules, with transition pathways from the CDM (ACM0002, AM0123, AMS-I.D and AMS-I.F).

11.6 | Data, uncertainty and monitoring

11.6.1 |The methodology specifies the data sources per parameter (the Annexes and Section 14), the treatment of uncertainty at the parameter level (Sections 7.4 and 13), and a digital monitoring system with a conservative gap-handling rule (Section 14).

11.7 | Policies and measures and relevant circumstances

11.7.1 |National, regional and local circumstances are taken into account through the regulatory-surplus test, the technology- and market-specific common-practice analysis, the lock-in assessment for combustion and reservoir technologies, and the host-system-specific grid emission factors. Binding policies and

measures in force are reflected in the baseline; only enforced regulation, never voluntary initiatives, is used to adjust it.

12| REVERSALS

12.1 | Assessment of Reversal Risks

12.1.1 |Not applicable. This methodology generates emission reductions through the avoidance of fossil-fuel-derived emissions; it does not cover removal-type activities and creates no carbon stock that could be reversed. The physical end-of-life risks of material-intensive hardware (battery recycling, marine-device removal, reservoir decommissioning) are managed through the mandatory End-of-Life Decommissioning Plan (Section 3.2) as a safeguard, and are not treated as reversal risks.

13| UNCERTAINTY QUANTIFICATION

13.1 | Approach for Uncertainty Management

13.1.1 |Uncertainty due to random errors shall be quantified using a 95 percent confidence interval, following appropriate statistical approaches. Consistent with the Requirements for Baseline Determination (MS400-04 6.3.1.5(b)(i)), uncertainty is addressed at the parameter level - by selecting conservative values for individual parameters, with the degree of conservativeness inversely proportional to the demonstrated data quality - rather than by an aggregate, error-propagation-based deduction to the baseline. In particular, grid emission factors and other monitored parameters are taken at the conservative bound using the quantitative uncertainty bounds (±%) of A6.4-AMT-007 (Table 4 / paragraph 102): the lower bound for baseline emissions (Case 2) and the upper bound for activity emissions (Case 1). Fixed parameters take their conservative default values from Annex 1, and missing monitored data are treated under the Conservative Replacement Rule (Section 14.1). The A6.4-AMT-007 Table 4 bounds are indicative and may understate true parameter uncertainty; conservative parameter selection here and the common-practice test (Section 6.6) therefore operate as the primary safeguards against over-crediting

13.1.2 |Where a 95 percent confidence interval is used to characterise a monitored parameter, it shall follow recognised statistical methods and be disclosed to the VVB.

14| MONITORING METHODOLOGY

14.1 | Requirements

14.1.1 |The activity developer shall implement a Monitoring Plan in the PDD / VPA-DD, setting out the procedures for collecting, recording, analysing and archiving all data required to quantify emission reductions and to verify the

applicability and safeguard criteria consistent with the digital MRV (dMRV) requirements of Section 3.4:

a.| **Metering accuracy and architecture.** Electricity generation, charging, discharging and captive consumption shall be measured with digital metering, capable of automated SCADA or API telemetry, meeting the accuracy tier for the metering point (Annex 4, A 4.2.1). For each metering point above 5 MW (generation) or 5 MWh (storage), metering shall be revenue-grade advanced metering infrastructure; at or below that marker a proportionate architecture (for example a programmable logic controller in place of a full SCADA system) is permitted, provided the accuracy tier and calibration requirements are met. The marker applies per metering point and does not depend on the activity's scale classification. Manual meter reading is not permitted for Modules ST, CG and VPP. Captive generation and captive consumption (Module CG) shall be measured with bidirectional metering at the relevant boundary, with an independent cross-check (for example settlement or invoice data) where available.

b.| **Temporal resolution.** Generation and captive meters shall record at least hourly. For storage assets (Module ST, and storage in Modules CG and VPP), charging and discharging shall be recorded at the settlement-interval resolution required by Tiered Temporal Accounting (Annex 2), with metered state-of-charge to support the rolling carbon pool.

c.| **Conservative Replacement Rule and completeness threshold.** Where telemetry gaps occur, missing data are neither interpolated nor omitted: electricity exported (baseline side) is set to zero for the gap, and electricity imported or fuel consumed (activity side) is set to its maximum plausible value. Data completeness in any monitoring period shall be at least 95% of the expected metered intervals per data stream; where completeness falls below this threshold, the affected data stream shall not be used to claim reductions for the affected intervals, and the conservative reconstruction above applies. The maximum contiguous gap eligible for conservative reconstruction, and the streams to which the threshold applies, are specified in the Monitoring Plan.

d.| **Aggregation Reconciliation Waiver (Module VPP and distributed PoAs).** For a VPP aggregating a large number of distributed captive or small scale generation, aggregating a large number of distributed nodes, aggregated telemetry may be sourced from original-equipment-manufacturer or platform interfaces at IEC accuracy class 1 or 2, in place of the revenue-grade requirement and the per-node Conservative Replacement Rule, subject to (i) a standardised conservative discount of 3% applied to the aggregated metered generation and storage discharge before the emission reductions are calculated and (ii) reconciliation of the aggregated result at each verification against an

independent settlement record — system-operator settlement data where the configuration exports to the electricity system, or the utility invoice or net-metering statement where output is consumed behind the meter (Annex 4, A 4.5).

e.| **Transition activities**. An activity transitioning from a legacy framework whose installed metering does not yet meet the accuracy or telemetry requirements shall bring its metering into conformance under a phased-implementation schedule set out at validation, with full conformance by a defined date; until then, the Conservative Replacement Rule and the completeness threshold apply, and reductions are claimed only for conforming data streams.

f.| **Calibration and archiving.** All meters and sensors shall be calibrated per manufacturer and national-metrology requirements; the calibration scope includes the instrument transformers in the metering chain where the metering point is on the high-voltage side. All monitored data and supporting evidence shall be archived for at least two years after the end of the crediting period.

14.1.2 | **Parameter list**: The parameter used in Sections 7–11 mapped with cited by ID in the equations (for example, "$EF_{grid,CM,y}$ [GR-M05]") in table below. Type N = not monitored (fixed at validation, per a referenced tool, or default); M = monitored during the crediting period.

Table 4: Parameter Table

ID	Parameter	Unit	Type	Source	Defined in Eq.
GR-N01	$EF_{Embodied,\text{gen},t}$	tCO_2e/MW ((per MWp DC for solar PV))	N	Default (Annex 1, A 1.4) or declaration (Annex 3, A 3.9)	eq. 36
GR-N02	$EF_{Embodied,\text{sto},s}$; $EF_{cell\ pack,s}$	tCO_2e/MWh; tCO_2e/MW (pumped hydro storage)	N	Default (Annex 1, A 1.5) or declaration (Annex 3, A 3.9)	eq.37
GR-N03	d	fraction/yr	N	Default (Annex 1)	eq.3
GR-N04	LT	years	N	A6.4-AMT-006	eq.3, 36, 37
GR-N05	EF_{res}	$kgCO_2e$/MWh	N	Default (Annex 1)	eq.30

GR-N06	$EF_{captive,fossil}$	tCO_2/MWh	N	Default (A6.4-AMT-007) / measured	eq.9, 10
GR-N07	GWP_{CH4}; $GWP_{\text{workingfluid}}$; GWP_{agent};	tCO_2e/t	N	AR5 (Annex 1)	eq.25, 33
GR-N08	DF_{ToU}	fraction	N	Default (Annex 2)	7, Annex 2
GR-N09	u	fraction	N	Default (Annex 1)	eq. 3
GR-N10	RUL	operating years	N	A6.4-AMT-006	eq. 3, 4
GR-N11	NCV_i	GJ/unit	N	Default / measured	eq. 22, 24
GR-N12	$EF_{CO2,i}$	tCO_2/GJ	N	Default (IPCC)	eq. 22
GR-N13	η_{gen}	fraction	N	Default / measured	eq. 24
GR-N14	τ	%	N	(Annex 1)	eq. 23
GR-N15	PD	W/m²	N	Validation	eq. 29, 30
GR-N16	$Cap_{gen,t}$	MW (MWp DC for solar PV)	N	Commissioning records	eq. 36
GR-N17	Cap_s; Cap_{aug}	MWh; MW (pumped hydro storage turbine)	N	Commissioning (updated on augmentation)	eq. 37
GR-N18	LCP	years	N	Maximum aggregate crediting period (≤ 15), or its remaining period for a technology included later	eq. 36, 37
GR-N19	$C_{bsl,i}$; $C_{act,i}$; A_i	tC/ha; ha	N	Validation	eq. 40
GR-N20	CF_y	fraction	N	Fixed (default 1)	eq. 18
GR-N21	RTE	fraction	N	Commissioning / verified	eq. 43
GR-M01	$EG_{facility,y}$	MWh	M	Measured (bidirectional)	eq. 1, 2, 5

GR-M02	$EG_{representative}$	MWh	M	Measured (validation-fixed)	eq. 3
GR-M03	$EG_{discharge,h,y}$	MWh	M	Measured (net)	eq. 7, 13, 43
GR-M04	$EC_{charge,h,y}$	MWh	M	Measured (gross)	eq. 32
GR-M05	$EF_{grid,CM,y}$	tCO_2/MWh	M	A6.4-AMT-007	eq. 1, 6, 9, 12, 38
GR-M06	$EF_{grid,OM,h,y}$	tCO_2/MWh	M	A6.4-AMT-007	eq. 7, 13, 43
GR-M07	$EG_{displaced,y}$	MWh	M	Measured (bidirectional)	eq. 8
GR-M08	$EG_{Captive,cons,y}$	MWh	M	Measured (bidirectional)	eq. 9
GR-M09	$FC_{i,y}$	t / m^3 / litres	M	Measured; recorded at least monthly by purpose (Section 8.3.2(e))	eq. 21, 24
GR-M10	$EC_{aux,y}$	MWh	M	Measured	eq. 31
GR-M11	$M_{e,released,y}$	T	M	Logs / weighing	eq. 33
GR-M12	DAF_y	fraction	M	MT400-05	eq. 16, 43
GR-M13	$EF_{grid,upper,y}$	tCO_2/MWh	M	A6.4-AMT-007 (Case 1 upper)	eq. 31
GR-M14	$EF_{grid,charge,h,y}$	tCO_2/MWh	M	A6.4-AMT-007	eq. 32
GR-M15	$EF_{grid,charge,attr,h,y}$	tCO_2/MWh	M	Rolling pool (Annex 2)	eq. 43
GR-M16	$M_{steam,y}$	t	M	Measured	eq. 25
GR-M17	$\omega_{steam,CO2,y}$; $\omega_{steam,CH4,y}$	t steam	M	Measured	eq. 25
GR-M18	$M_{workingfluid,y}$	t	M	Measured	eq. 27–28
GR-M19	$r_{reinj,y}$	fraction	M	Measured	eq. 25
GR-M20	TEG_y	MWh	M	Measured	eq. 30
GR-M21	$EG_{wake,y}$	MWh	M	Modelled (wake/wind-flow)	eq. 38

GR-M22	$EG_{agg,gen,y}$ $EG_{agg,discharge,h,y}$	MWh	M	Platform aggregation	eq. 12, 13
GR-M23	$EG_{legal,y}$	MWh	M	Determined (regulation)	eq. 2
GR-M24	y_{aug}	Year	M	Recorded	eq. 37
GR-M25	*Operating records of fossil-fuelled units*	time-stamped log	M	Burner, boiler and generator controller records (Section 8.3.2(e))	eq. 23; Section 8.3.2(b), (c)

14.2 | Data and parameters not monitored

14.2.1 |The following fixed parameters are determined once (at validation, or per the referenced tool) and are not monitored during the crediting period. Default values and their derivation are given in the Annexes; only the principal parameters are tabulated here, and any further fixed parameters follow the same template.

Parameter ID	**GR-N01**
Data / Parameter	$EF_{embodied,gen,t}$
Description	Embodied emission factor of the technology class of generation component t per unit of installed capacity, covering manufacture, transport and installation, and end-of-life (Annex 3, Section A 3.3)
Data unit	tCO_2e/MW, numerically equal to kg CO_2e/kW (per MWp DC for solar PV; per MW AC nameplate otherwise)
Equation(s)	eq. 36
Purpose of data	☐ Baseline ☐ Activity ☒ Leakage
Value(s) applied	Per Annex 1, Section A1.4
Source of data	☐ Measured ☒ Other sources (Annex 1 default, or an eligible declaration under Annex 3, Section A 3.9)
Choice of data / justification	Default per technology class (Annex 1, Section A 1.4). An activity-specific value only under Annex 3, Section A 3.9.
Additional comments	Fixed at commissioning for the installed equipment and applied to installed capacity (GR-N16), independent of output

Parameter ID	**GR-N09**
Data / Parameter	u
Description	Fixed conservative uplift applied to the Module BO representative baseline (replacing the historical standard deviation)

Data unit	fraction
Equation(s)	eq. 3
Purpose of data	☒ Baseline ☐ Activity ☐ Leakage
Value(s) applied	Annex 1
Source of data	☐ Measured ☒ Other sources (Annex 1)
Choice of data / justification	A modest, fixed buffer superseding the site-variable σ
Additional comments	A higher u yields a higher (more conservative) baseline and a lower credited increment

Parameter ID	**GR-N10**
Data / Parameter	RUL
Description	Remaining Useful Life of the pre-existing Module BO asset, in operating years
Data unit	operating years
Equation(s)	eq. 3, 4
Purpose of data	☒ Baseline ☐ Activity ☐ Leakage
Value(s) applied	Determined under A6.4-AMT-006 from site / OEM evidence
Source of data	☐ Measured ☒ Other sources (A6.4-AMT-006)
Choice of data / justification	A6.4-AMT-006; ≥ 5 operating years required at the start date (Section 3.2)
Additional comments	Governs the decay and cut-off of the Declining Baseline; expressed in operating, not calendar, years

Parameter ID	**GR-N14**
Data / Parameter	τ
Description	Permissible fossil-fuel (ignition/start-up) fraction of electricity output
Data unit	%
Equation(s)	eq. 23
Purpose of data	☐ Baseline ☒ Activity ☐ Leakage
Value(s) applied	**5%** (Annex 1)
Source of data	☐ Measured ☒ Other sources (Annex 1)
Choice of data / justification	Emergency-backup hours limited separately
Additional comments	Exceedance voids the affected interval only (eq. 23), not the monitoring period

Parameter ID	**GR-N16**
Data / Parameter	$Cap_{gen,t}$
Description	Installed capacity of generation component t
Data unit	MW: rated DC power of the installed modules at standard test conditions (MWp) for solar PV; AC nameplate capacity for other technologies
Equation(s)	eq. 36
Purpose of data	☐ Baseline ☐ Activity ☒ Leakage
Value(s) applied	As commissioned; updated when capacity is added or replaced
Source of data	☐ Measured ☒ Other sources (manufacturer datasheets, as-built single-line diagram, commissioning certificate)
Choice of data / justification	Nameplate capacity fixes the embodied burden independently of the yield forecast. Solar PV uses DC capacity because its default is expressed per MWp of installed modules.
Additional comments	Under Module BO, only the capacity of new or replaced generating equipment.

Parameter ID	**GR-N21**
Data / Parameter	RTE
Description	Round-trip efficiency of the storage system
Data unit	fraction
Equation(s)	eq. 43
Purpose of data	☐ Baseline ☒ Activity ☐ Leakage
Value(s) applied	From the commissioning test certificate; verified
Source of data	☐ Measured ☒ Other sources (commissioning) / periodically re-measured
Choice of data / justification	Commissioning test; a conservative (lower) value increases the attributed charging emission per unit discharged
Additional comments	Expresses charging emissions per unit discharged in eq. 43

(GR-N02–N08, N11–N13, N15, N17–N20 follow the identical template; their values and sources are in Annex 1)

14.3 | Data and parameters monitored

14.3.1 |The following parameters are monitored during the crediting period. The principal parameters are tabulated; geothermal fugitive parameters ($M_{steam,y}, \omega_{steam,CO2,y}, \omega_{steam,CH4,y}, M_{workingfluid,y}$), reservoir generation (TEG), and additional module-specific parameters are monitored on the same template.

Parameter ID	GR-M01
Data/parameter:	$EG_{facility,y}$
Description	Net electricity supplied by the activity plant to the system in year y
Data unit:	MWh
Equation(s)	eq 1, 2, 5
Purpose of data:	☒ Baseline ☐ Activity ☐ Leakage
Value(s) applied	Monitored
Source of data	☒ Measured
Measurement methods and procedures:	Bidirectional meter at the interconnection point meeting the accuracy tier of Annex 4 (A 4.2.1), revenue-grade where the metering point exceeds 5 MW (Section 14); automated SCADA / API readout.
Measurement and updating frequency:	Continuous; aggregated monthly and annually.
QA/QC procedures:	Calibration per metrology requirements; cross-check against settlement / invoices; Conservative Replacement Rule for gaps; completeness threshold (Section 14.1)
Choice of data / justification	Directly metered.
Comments:	Net of auxiliary consumption where so reported (see GR-M10).

Parameter ID	GR-M08
Data/parameter:	$EG_{Captive,cons,y}$
Description	Metered captive/contracted consumer load supplied by the activity (Module CG)
Data unit:	MWh
Equation(s)	eq. 9
Purpose of data:	☒ Baseline ☐ Activity ☐ Leakage
Value(s) applied	Monitored
Source of data	☒ Measured
Measurement methods and procedures:	Bidirectional metering at the consumer boundary distinguishing captive-supplied from grid-supplied load per interval; for a VPP, from the platform

Measurement and updating frequency:	Continuous
QA/QC procedures:	Independent cross-check (settlement/invoice) where available; Conservative Replacement Rule
Choice of data / justification	-
Comments:	Underpins the captive/grid share in eq. 9

Parameter ID	**GR-M14**
Data/parameter:	$EF_{grid,charge,h,y}$
Description	Charging emission factor in interval h (storage)
Data unit:	tCO_2/MWh
Equation(s)	eq. 32
Purpose of data:	☐ Baseline ☒ Activity ☐ Leakage
Value(s) applied	Monitored
Source of data	☒ Other (A6.4-AMT-007)
Measurement methods and procedures:	Tier 2: hourly operating margin; Tier 1: the maximum operating-margin factor in the load block (conservative for an activity emission); zero under the curtailment exception (Annex 2)
Measurement and updating frequency:	Per settlement interval (Tier 2) or load block (Tier 1)
QA/QC procedures:	Transparent derivation to the VVB; curtailment evidence per Annex 2
Choice of data / justification	-
Comments:	Storage chain (Annex 2); paired with the attributed factor GR-M15

Parameter ID	**GR-M15**
Data/parameter:	$EF_{grid,charge,attr,h,y}$
Description	Charging emission factor attributed to the energy discharged in interval h, via the energy-weighted rolling carbon pool
Data unit:	tCO_2/MWh
Equation(s)	eq. 43
Purpose of data:	☐ Baseline ☒ Activity ☐ Leakage

Value(s) applied	Monitored
Source of data	☒ Other (calculated, Annex 2)
Measurement methods and procedures:	Energy-weighted rolling carbon pool applied to the metered charge/discharge series (Annex 2); not a discrete queue and not metered state-of-charge attribution
Measurement and updating frequency:	Per settlement interval; reconciled at the monitoring-period aggregate
QA/QC procedures:	Replicable derivation disclosed to the VVB; monitoring-period zero-floor (Section 10.2)
Choice of data / justification	-
Comments:	Storage chain (Annex 2); combined with RTE (GR-N21) in eq. 43

Parameter ID	**GR-M21**
Data/parameter:	$EG_{wake,y}$
Description	Reduction in the net generation of an adjacent third-party wind or marine array attributable to the activity's wake
Data unit:	MWh
Equation(s)	eq. 38
Purpose of data:	☐ Baseline ☐ Activity ☒ Leakage
Value(s) applied	Monitored
Source of data	☒ Other (modelled)
Measurement methods and procedures:	Wake / wind-flow (or hydrodynamic) model of the affected array's yield with and without the activity, verified by the VVB
Measurement and updating frequency:	Once at validation; re-assessed on material change
QA/QC procedures:	Model and inputs disclosed; zero where the affected array is itself a registered activity
Choice of data / justification	-
Comments:	-

(GR-M02–M07, M09–M13, M16–M20, M22–M24 follow the identical template; the geothermal, reservoir, auxiliary, fire-suppression, VPP-aggregation, legal-generation and augmentation parameters are monitored as tabulated in 14.2.)

15| MONITORING REQUIREMENTS FOR ACTIVITIES WITH REVERSAL RISKS

15.1.1 |**Not applicable.** As set out in Section 12, this methodology covers emission-reduction (avoidance) activities only, with no removal or carbon-stock component and therefore no reversal risk to monitor. Activity developers shall nonetheless monitor compliance with the End-of-Life Decommissioning Plan and its progressive capitalisation (Section 3.2) and report it at each verification, as an environmental safeguard rather than a reversal control.

16| APPLICATION TO PROGRAMME OF ACTIVITIES (POA)

16.1 | General Requirements

16.1.1 |This methodology may be applied under a Programme of Activities (PoA) in accordance with the GS4GG Programme of Activities Requirements. The modular architecture is well suited to a PoA, and the following provisions apply:

a.| **Eligibility of component activities**: Each Voluntary Project Activity (VPA) shall independently satisfy the applicability conditions (Section 3), demonstrate additionality at the module level (Section 6), or, where micro-scale, via the positive-list route (Section 6.2), and apply the baseline, activity-emission, leakage and net-reduction procedures (Sections 7-10) for the modules it deploys.

b.| **Scale:** Scale is assessed for each VPA, and the PoA may include any number of VPAs. Scale thresholds are assessed on the Activity Cluster where Section 3.5 applies

c.| **Module mixing within a PoA:** Different VPAs within the same PoA may deploy different modules or combinations; the eligibility, baseline and crediting of each are determined independently for the modules present.

d.| **Virtual power plants:** A VPP (Module VPP) aggregating distributed energy resources is the natural unit of a PoA: the digital aggregation perimeter defines the boundary, and the DERs mapped to the control platform constitute the component installations. Additionality, common practice and scale are assessed at the aggregator/platform level (Sections 6.2 and 6.6).

e.| **Additions to a VPA:** A VPA that adds capacity or a module after registration does so as a co-located new activity or a new VPA with its own crediting period, additionality demonstration and baseline (Sections 3.1 and 6.7); it is not a mid-period expansion of the existing VPA. Capacity increases within the scope and crediting limits of the GS4GG Design Change Request Requirements and Procedures proceed as Design Changes to the existing activity under that document, including its additionality re-assessment, submission window and prior-

consideration conditions; this paragraph governs additions beyond those limits or ceilings, or involving a new co-located technology.

f.| **Standardised inclusion:** The PoA shall define standardised eligibility criteria and a methodology-consistent inclusion procedure for adding VPAs, including the data-and-parameter and dMRV requirements of Section 14 and the sampling provisions of Section 17. For micro-scale component activities, the inclusion procedure may be streamlined: conformity with the standardised eligibility criteria and, where relied upon, the Positive List conditions (Section 6.2) – if valid; is demonstrated at inclusion and assessed at the performance review, applying the Real Case VPA and Regular Case VPA structure of the GS4GG Programme of Activities Requirements. Additions above the micro-scale threshold follow paragraph (d).

16.2 | VPA Inclusion & Modular Homogeneity

a.| The Coordinating/Managing Entity (CME) shall define clear eligibility criteria for the inclusion of VPAs.

b.| VPAs within the PoA need not deploy the same module, provided the PoA-DD/Real Case VPA-DD set out the quantification logic for each allowable Module. For example, a single PoA may aggregate VPA 1 (Module CG: Captive Solar) and VPA 2 (Module ST: Commercial BESS dispatch).

c.| VPAs shall not be regarded as the real/regular case "type" if they deploy different Modules. The CME shall describe transparently which VPAs belong to which module or module combination to ensure monitoring requirements are correctly applied.

17| RENEWAL OF CREDITING PERIOD

17.1 | Crediting Period Renewal Requirements

17.1.1 |The crediting period is five years, renewable twice (a maximum of 15 years). At each renewal, the activity developer shall:

a.| **Re-demonstrate additionality** - regulatory surplus (mandatory), Ongoing Financial Need, and common practice re-assessed for the prevailing market (Section 6.8). The Ongoing Financial Need test applies the same financial-analysis option and basis as the first crediting period, assessed on the activity's operating economics irrespective of any change in ownership (Section 6.8), with updated assumptions, takes account of all carbon and non-carbon revenues, and meets a minimum evidence set (updated operating budgets, augmentation schedules, end-of-life provisioning). Where the activity would be viable against its applicable benchmark without carbon revenue in the renewed period, the crediting period shall not be

renewed. Persistent ongoing financial need does not, in itself, waive the common-practice re-assessment.

b.| **Update the baseline** - re-derive the grid emission factor under A6.4-AMT-007 using data no older than three years meeting the Grid-Emission-Factor Addendum vintage/resolution requirements, re-apply the Declining Baseline for Module BO, and update the ambition DAF for the renewed period (Section 7).

c.| **Confirm equipment status** - demonstrate that the relevant assets remain within their technical lifetime under A6.4-AMT-006; emission reductions are not issued beyond the technical lifetime.

d.| **Upgrade temporal accounting** – storage activities applying Tier 1 shall upgrade to Tier 2 (hourly marginal) at this renewal where the host system now publishes or can supply the necessary data, in accordance with the data-readiness pathway of the Grid-Emission-Factor Addendum (Annex 2; Section 3.2). Where the host system still does not publish the data, Tier 1 continues, subject to its conservativeness discount, and the upgrade applies at the first verification after the data become available**.**

e.| **Re-confirm NDC / LT-LEDS alignment and safeguards** - confirm continued alignment with the host Party's latest NDC (Section 11.4) and continued conformance with the GS4GG Safeguarding Principles and the End-of-Life Decommissioning Plan.

17.2 | General requirements for data and information sources

17.2.1 |Where a choice of data sources exists, the activity developer shall prefer, in order: directly metered or measured activity data; official government or system-operator data; peer-reviewed or recognised international data (e.g., IPCC, NREL); and, last, the conservative default values in the Annexes. Data sources shall be **accessible to the VVB** for verification. Where data quality is uncertain, the value that does not overestimate emission reductions shall be selected. All data, assumptions, derivations and supporting evidence shall be documented in the PDD / VPA-DD and monitoring reports and archived for at least two years after the end of the crediting period.

17.3 | General requirements for sampling

17.3.1 |Where sampling is used (in particular for a PoA or a VPP with numerous component installations), the activity developer shall apply a sampling plan consistent with the GS4GG sampling requirements, achieving a 90/10 confidence/precision for the sampled parameter, with the sample frame, method and reliability disclosed to the VVB.

Annex -1|Default Values and Emission Factors

A 1.1| Purpose and use of this Annex:

A 1.1.1| **Purpose:** This Annex provides the default values, emission factors and assessment conventions referenced in Sections 7-10. It is to be read with the methodological tools listed in Section 4. The Annex is an integral and binding part of the methodology.

a.| **Use of defaults**: Unless stated otherwise, an activity developer shall apply the default value in this Annex, or a more conservative activity specific value (one that does not increase the net emission reductions). A less-conservative activity-specific value may be applied only with a publicly available, third-party-verified, internationally recognised source (e.g., ISO 14040/14044/14067 LCA or EPD), and where the methodology expressly permits it. For embodied emission factors, Annex 3, Section A 3.9 sets the conditions in place of this paragraph.

b.| **Conservative direction:** Baseline parameters (grid and captive emission factors) are conservative when lower; activity and leakage parameters (reservoir factor, embodied factors) are conservative when higher. Defaults are selected and rounded accordingly, from peer-reviewed or intergovernmental sources.

A 1.2| General conventions

A 1.2.1| **Global Warming Potentials (AR5, 100-year):** All GWPs are the 100-year values of the IPCC Fifth Assessment Report (AR5) without climate-carbon feedbacks, as adopted by GS4GG (Section 14). The embodied emission factors of Sections A 1.4 and A 1.5 are life-cycle footprints whose source studies use AR5 or AR6 characterisation; Annex 3, Section A 3.4.4 applies.

A 1.2.2| **Embodied-emissions boundary:** The embodied (leakage) factors cover the manufacture, transport and installation, and end-of-life of the hardware, on the boundary set out in Annex 3, Section A 3.3. Activity-specific factors may replace the defaults only under Annex 3, Section A 3.9. The defaults are reviewed under Annex 3, Section A 3.10.

A 1.2.3| **Downward Adjustment Factor (DAF).** The DAF (Section 7.3) is selected directly by the developer from GS4GG PAA Tool PAA MT400-05 and is not tabulated here.

A 1.3| Global warming potentials (GWP)

Parameter	GWP_{CH4}; GWP_{N2O}; $GWP_{workingfluid}$; GWP_{agent};
Data unit	tCO_2e / tgas (100-year, AR5)
Equations	Section 8 — eq. 25–28 (geothermal); eq. 33 (fire suppression)

Value(s) applied	Methane (CH_4): 28 Nitrous oxide (N_2O): 265 Working fluids (isobutane ≈ 3; n-/iso-pentane ≈ 4; ammonia-water ≈ 0); Fire-suppression agents (HFC-227ea/FM-200 = 3,350; HFC-125 = 3,170; HFC-23 = 12,400; HFC-236fa = 8,060; FK-5-1-12/Novec 1230 < 1; Pure inert gases and IG-blends = 0; CO_2 = 1; IG-541 ≈ 0.10 tCO_2e/t from its CO_2 fraction). Source:
Source	IPCC (2013, WGI Ch. 8, Table 8.A.1); manufacturer specifications for blends.
Derivation / justification	AR5 100-year values are applied per Section 14, consistent with UNFCCC reporting (hence CH_4 = 28, not the AR4 value of 25 or AR6 value of ~27). CO_2 has a GWP of 1 by definition; CO_2-containing inert blends therefore carry a small non-zero GWP from their CO_2 fraction. For a commercial blend, GWP_{agent} is the mass-weighted GWP of its constituents, or the manufacturer-declared value.
Comments	The methodology encourages zero-/low-GWP fire-suppression agents (FK-5-1-12; pure inert gases) and low-GWP working fluids; where used, the corresponding activity emission approaches zero. Captured/recovered CO_2 used as an agent may be treated as net-zero only where its atmospheric capture is verified.

A 1.4| Embodied emission factors – generation

Parameter	$EF_{Embodied,\text{gen},t}$
Data unit	tCO_2e per MW of installed capacity, numerically equal to kg CO_2e per kW: per MWp DC for solar PV; per MW AC nameplate for other technologies
Equations	Section 9.4.3, eq. 36
Value(s) applied per technology	See Table 1.1.
Solar PV build-up (tCO_2e/MWp DC)	Module: crystalline silicon 775; cadmium telluride 374. Mounting and electrical: standard 198; concrete foundations or ballast 948. Installation and transport: 13. End-of-life: 10. The PV default is the sum of the four terms, rounded up to the nearest 10. An eligible declaration replaces the module term only (Annex 3, Section A 3.9).

Class determination	a. The class is determined from the design documents at validation and confirmed against the as-built records at first verification. b. Concrete foundations or ballast applies where the design documents show concrete foundations or ballast blocks. Standard mounting applies otherwise, including fixed-tilt and tracking structures on driven or screwed piles and rooftop mounting without ballast. c. Hydropower: new dam and reservoir applies where the activity constructs a new dam or reservoir; run-of-river and dam-toe applies otherwise. d. Wind: floating offshore applies where the turbine substructure is floating. e. Geothermal: the class follows the plant's conversion technology and resource type. f. Where an installation combines classes or mounting types, each part is assessed separately on its installed capacity. g. Where the class cannot be verified from the design documents, the highest default for the technology applies.
Source	Gold Standard (2026), which sets out the evidence and derivation for each class. For the PV build-up: module term from Gold Standard (2026); mounting and electrical, and installation and transport, from Smith et al. (2024), with concrete foundations and ballast from Roy and Pearce (2023); end-of-life from Gold Standard (2026).
Derivation / justification	Each default is the 75th percentile of a lognormal distribution fitted to the hardware-only life-cycle studies of its class, rounded up to the nearest 10 (Annex 3, Section A 3.4).
Comments	Recovered under Section 9.4.3. Reviewed under Annex 3, Section A 3.10. For a technology not listed, a value from a credible peer-reviewed source may be used, documented and justified.

Table 1.1. Default embodied emission factors for generation, by technology class

Technology or class	Default (tCO_2e/MW)	Capacity basis
Solar PV, crystalline silicon, standard mounting	1,000	MWp DC
Solar PV, crystalline silicon, concrete foundations or ballast	1,750	MWp DC
Solar PV, cadmium telluride, standard mounting	600	MWp DC

Solar PV, cadmium telluride, concrete foundations or ballast	1,350	MWp DC
Wind, onshore and fixed-bottom offshore	1,190	MW AC nameplate
Wind, floating offshore	2,380	MW AC nameplate
Hydropower, run-of-river and dam-toe	1,490	MW AC nameplate
Hydropower, new dam and reservoir	2,090	MW AC nameplate
Geothermal, hydrothermal flash	1,080	MW AC nameplate
Geothermal, hydrothermal binary	4,020	MW AC nameplate
Geothermal, enhanced geothermal systems	10,560	MW AC nameplate
Concentrated solar power	3,280	MW AC nameplate
Biomass, biogas and landfill-gas plant	1,670	MW AC nameplate
Marine, tidal and wave	2,000	MW AC nameplate

A 1.5| Embodied emission factors – storage

Parameter	$EF_{Embodied,sto,s}$; $EF_{cell\ pack,s,y}$
Data unit	tCO_2e / MWh of installed (electrochemical storage); tCO_2e/MW of installed turbine capacity (pumped hydro storage)
Equation	Section 9 — eq. 37
Value(s) applied	Lithium iron phosphate (LFP): 99 (= 69 cell/pack [95th percentile] + 30 balance of plant) Nickel-manganese-cobalt (NMC): 145 (= 115 cell/pack [95th percentile] + 30 balance of plant) Cell/pack distribution (life cycle, kg CO_2e/kWh = tCO_2e/MWh): LFP: 69 and NMC: 115. The 95th percentile is applied as the conservative default for a leakage penalty. Pumped hydro storage: 1,280 tCO_2e per MW of installed turbine capacity. Infrastructure only: dam or reservoir works, tunnels and penstock, powerhouse, electromechanical equipment, grid connection and construction, with end-of-life (Annex 3, Section A 3.3). Source: Gold Standard (2026). The augmentation term of eq. 37 does not apply.
Source	Cell/pack: Peiseler et al. (2024) (cradle-to-gate distributions), Balance of plant (containers, HVAC, power-conversion systems):

	full-system LCA evidence, e.g., Le Varlet et al. (2020) (full residential systems ~200 kg CO_2e/kWh of capacity). Corroboration of cell range: literature surveys reporting ~58-92 kg CO_2e/kWh per cell.
Derivation / justification	Two conservative adjustments are applied. (i) The 95th-percentile cell/pack value is taken as the default (not the median), because a median default for a leakage penalty would reward high-carbon (e.g., coal-grid-manufactured) supply chains with an unearned discount and erode the incentive to provide a verified EPD. (ii) A balance-of-plant adder of 30 tCO_2e/MWh extends the cell-only boundary to the utility-scale system (enclosure, thermal management, power-conversion); 30 is conservative-low, since full-system residential LCAs report substantially higher peripheral contributions and utility systems share infrastructure across a larger capacity. These upper-bound defaults apply where the developer cannot provide a third-party-verified ISO 14040/44/67 EPD; a verified EPD (cell/pack + BOP) may be substituted.
Augmentation ($AUG_{s,y}$)	Where cells are replaced during the crediting period to maintain capacity**,** the augmentation embodied uses the cell/pack factor only (excluding balance of plant) and is amortised over the remaining crediting-period years, consistent with eq 37: $AUG\ contribution = Capaug \times EFcell/pack,s \div MAX(1, LCP - yaug + 1)$. A default augmentation cycle of ~10 years applies for lithium-ion systems unless the OEM specifies otherwise.
Comments	Amortised over N (Section 9.4.3, eq. 37).

A 1.6| Displaced-fleet symmetry:

A 1.6.1| Displaced-fleet symmetry (deliberate conservative asymmetry). The methodology deducts the activity's embodied emissions but does not credit the embodied emissions of the displaced fossil fleet (the upstream fuel-supply-chain plus plant-construction component — the non-combustion life-cycle component, the combustion component being already captured in the operating-margin grid factor). The direction is unambiguously conservative: the displaced-fossil non-combustion component is of the same order as, or larger than, the renewable embodied term. Indicatively, life-cycle assessments place the non-combustion component of coal at roughly 10–50 gCO_2e/kWh and of natural gas at roughly 80–120 gCO_2e/kWh (dominated by upstream methane (IPCC, 2011, Annex II). The Section A 1.4 defaults correspond to roughly 5 to 50 gCO_2e/kWh at reference yields (Gold Standard, 2026). Not crediting the avoided fossil embodied therefore forgoes a term comparable to or larger than the renewable embodied deduction, so the omission understates the net reduction and cannot inflate it. The precise host-specific magnitude would be computed from the composition of the displaced fleet (the same margin data used for the

baseline); the point for environmental integrity is that the omission is conservative by construction.

A 1.7| Standardised annual degradation rates

The onshore-wind rate is corroborated across four independent large-fleet analyses; offshore wind is treated separately given the absence of consensus

Parameter	d
Data unit	fraction per year
Equations	Section 7 - eq 3 (Module BO Declining Baseline)
Value(s) applied	Solar photovoltaic (crystalline silicon): 0.5% / year Onshore wind: 0.5% / year Offshore wind: a site-specific rate from ≥3 years of verified SCADA data shall be used; where unavailable, Module BO offshore crediting is not permitted (no default fallback) Geothermal: ~0.5% / year (indicative; site-specific) Hydropower: negligible (~0% / year; site-specific, subject to refurbishment)
Source	PV: Jordan & Kurtz (2013) and Jordan et al. (2016) — meta-analysis of ≈ 11,000 rates across ≈ 200 studies; x-Si median 0.5–0.6%/yr. Onshore wind: Hamilton et al. (2020; US, 917 plants) — 0.53%/yr pre-2008 and 0.17%/yr post-2008 vintages; Germer & Kleidon (2019; Germany) — 0.63%/yr; Olauson et al. (2017; Sweden); Staffell & Green (2014; UK) — 1.6%/yr upper bound. Offshore wind: evidence is split and no reliable ageing default exists, Benini & Cattani (2022) find offshore technical efficiency does not decline with age (83–98% across European farms); Astolfi & Pandit (2022) likewise report no statistically significant decline for UK offshore, attributing this to a young fleet and rotor diameters rising 80→164 m; against this, Lorentzen et al. (2024) find that UK offshore capacity factors rise in the first years of operation and then decline, which they attribute to immature technology; Staffell & Green (2014) suggest offshore may degrade faster, on thin data.
Derivation / justification	**PV** rests on a large meta-analysis and is retained at 0.5%/yr. **Onshore wind** is set at 0.5%/yr, as the empirically *accurate* older-vintage rate, not as a conservative device: Hamilton et al. (2020) report 0.53%/yr for pre-2008 (older) turbines but ≈ 0.17%/yr for post-2008 (new) turbines; because Module BO repowers older-vintage assets reaching end-of-life, the older-vintage rate is the empirically and contextually correct value. The accurate older-vintage rate is preferred over the more-

	conservative-but-inaccurate low rate; environmental-integrity conservatism is instead secured by the fixed uplift u (A.1.8) and the Remaining-Useful-Life truncation, not by the degradation rate. **Offshore wind:** no robust ageing default exists (see Source), and, by the same mechanism, a *higher* offshore rate would *reduce* baseline conservatism in Module BO; offshore Module BO therefore requires a verified site-specific rate (≥ 3 yr SCADA), failing which offshore Module BO crediting is not available.
Comments	Applies only to Module BO, combined with the fixed conservative uplift u (A.1.8). Degradation is mildly non-linear, accelerating after ≈ 10 years (Hamilton et al., 2020); the flat rate is conservative for the baseline, and a two-phase profile may be applied where supported by verified site data.

A 1.8| Module BO conservative uplift (u).

Field	Content
Parameter	u
Data unit	fraction
Equation	Section 7, eq. 3
Value applied	**0.06** (a fixed fractional uplift applied uniformly to the representative-year baseline, eq. 3).
Derivation / justification	A fixed buffer is transparent and uniform. 0.06 is set at the inter-annual-variability standard deviation of the highest-variability eligible technology, onshore wind, for which a σ of ≈ 6% of annual mean wind speed is the value widely applied in the wind-energy industry (Pryor et al., 2018; whole-fleet annual-energy-production inter-annual variability is of comparable order, median ≈ 8%), and is conservative relative to solar PV, whose annual-yield coefficient of variation is ≈ 3–4% (Gueymard & Wilcox, 2011). Because the Module BO baseline is anchored to a single representative operating year, a low-resource representative year would understate the counterfactual; a ≈ 1σ uplift ensures the baseline is conservatively high. Inter-annual variability is the standard deviation of annual generation over the record (the standard P50/P90 construction).
Comments	A higher u yields a higher (more conservative) baseline and a lower credited increment. The 0.06 default is a floor: a developer may apply a higher value, but not a lower one, preserving the uniform, transparent buffer and the conservative direction.

A 1.9| Default technical lifetimes

Parameter	LT (technical lifetime)
Data unit	Years
Equations	Sections 7 (RUL) and 9 (technical-lifetime bound on crediting)
Value(s) applied	Solar photovoltaic: 25-30 Onshore wind: 20-25; Offshore wind: 25-30 Concentrated solar power: 25-30; Geothermal: 25-30 Hydropower: 40-80 Battery (lithium-ion): 10-15; Pumped hydro storage: 50-80
Source of data	IEA / IRENA / NREL technology data. The binding determination is made under A6.4-AMT-006.
Derivation / justification	Indicative defaults; the operative technical lifetime is determined per A6.4-AMT-006 from site/manufacturer evidence. Used to set the Remaining Useful Life (Module BO) and the embodied amortisation period N (capped at the crediting period <= 15 years).
Comments	The embodied amortisation period N is the shorter of the technical lifetime and the crediting period, or its remaining period for a technology included later (Section 9.4.3).

A 1.10| Reservoir emission factor

Parameter	EF_{res}
Data unit	$kgCO_2e$/ MWh
Equations	Section 8 - eq 30
Value(s) applied	100
Source of data	Hydropower Sustainability Standard and the Hydropower Sustainability Guidelines on Good International Industry Practice.
Derivation / justification	Applied where 4 < power density <= 10 W/m^2. The updated value of 100 kg CO_2e/MWh is adopted in preference to the legacy CDM EB-23 value of 90 kg CO_2e/MWh: the higher figure is more conservative for an activity emission and reflects updated science.
Comments	Power density > 10 W/m^2: AE_{hp} = 0. New/expanded reservoirs at power density <= 4 W/m^2: ineligible (Section 3.2.4(a)). Run-of-river classification (Section 3.2.4(a)): storage in the impoundment of no more than 24 hours at design flow, which

	matches the threshold used for run-of-river and pondage plants (reservoir capacity divided by net generating capacity of 24 hours or less) by the European Network of Transmission System Operators for Electricity (ENTSO-E, 2019). The condition that the hydraulic residence time be below two days is taken from A6.4-AMM-003 (United Nations Framework Convention on Climate Change, 2026), which applies it together with the 24-hour storage condition.

A 1.11| Captive fossil-fuel emission factor

Parameter	$EF_{captive,fossil}$
Data unit	tCO_2 / MWh
Equations	Section 7 — eq. 8, 9, 10 (Module CG)
Value(s) applied	0.54 (default, diesel generator)
Source of data	UNFCCC Methodological tool: Emissions from electricity generation and consumption (A6.4-AMT-007), Table 3 (paragraph 120, Step 8, Option B).
Derivation / justification	The mandatory Case 2 conservative default for oil-fired power units under A6.4-AMT-007 (paragraph 120, Step 8, Option B, Table 3). A plant-specific value from metered fuel and the genset's measured efficiency is preferred and shall be used where available.
Comments	Applied under the MIN (captive, grid) rule (eq 9); for an off-grid facility the captive factor applies directly (eq 10). for simultaneous captive/grid draw, the MIN (captive, grid) rule applies (Section 7.3).

A 1.12| Fossil-fuel properties and the fossil-fuel cap

Parameter	NCV_i ; $EF_{CO2,i}$; τ
Data unit	GJ per unit; tCO_2 / TJ; per cent
Value(s) applied	• Diesel / gas oil: NCV 43.0 GJ/t; EF_{CO2}74.1 tCO_2/TJ • Natural gas: EF_{CO2}56.1 tCO_2/TJ • Other fuels: IPCC (2019 refinement) Tier 1 default NCV and EF_{CO2} applying the upper bound of the 95% confidence interval for Case 1 emissions and the lower bound for Case 2 emissions. The ×1.002 multiplier (eq. 22) adds CH_4/N_2O to the CO_2-only factor. • Fossil-fuel cap τ = 5% of the activity's electricity generation in each calendar month (Section 8.3)

	• Backup operation is limited separately to 100 operating hours in each calendar year, excluding officially declared disaster or system outage. A month that fails either limit, or the co-firing traceability condition, is not credited (Section 8.3). Source: IPCC (2019), Vol. 2.
Source of data	2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 2 (Energy), Tier 1.
Derivation / justification	Standard IPCC Tier 1 defaults; the ×1.002 multiplier in eq. 22 adds CH_4 and N_2O to the CO_2-only factor EF_CO2 (no double count — the factor is CO_2-only). The cap is tested for each calendar month so that the period tested and the period that loses crediting are the same. An hour or a day would be breached by a single cold start, and a year would absorb a concentrated episode of co-firing. Withholding crediting only for the periods in which a threshold is exceeded, while deducting the associated emissions in full, follows ACM0002 (version 22.0, paragraphs 8(d) and 51) for grid or fossil charging of storage.
Comments	Ignition, start-up and backup fuel all count towards the cap, except backup fuel combusted during officially declared disaster or system outage (Section 8.3). Activity-specific NCV/EF from fuel analysis may be used where verifiable.

A 1.13| Land-use-change carbon stocks

Parameter	$C_{bsl,i}$; $C_{act,i}$
Data unit	t C / ha (summed over the five IPCC pools)
Equations	Section 9 - eq 39-40
Value(s) applied	• Forest land (tropical): 120-250 • Grassland: ~88 • Cropland: 60-90 • Conversion to industrial / 'settlement' use (e.g., ground-mounted solar): living biomass assumed fully lost (post-conversion biomass = 0); soil organic carbon may remain, subject to justification
Source of data	2019 Refinement to the 2006 IPCC Guidelines, Volume 4 (AFOLU), Tier 1.
Choice of data / justification	Tier 1 defaults selected by climate zone and land type, documented with satellite imagery or land-use records. Higher tiers permitted with verifiable region-specific data. The net stock loss ΔC_{LUC} is converted to CO_2 by the stoichiometric factor 44/12 and floored at zero (apparent sequestration is not credited).
Comments	Applies only where the activity converts land (eq 39-40).

A 1.14| Wake / shadowing assessment conventions

Parameter	Wake / shadowing assessment
Equations	Section 9 - eq 38
Method applied	A wake / wind-flow (or hydrodynamic) model, Jensen/PARK, eddy-viscosity, or computational fluid dynamics (CFD), is required to quantify the reduction in an adjacent third-party array's net generation attributable to the activity's wake. Screening distances (onshore 5 km; offshore 100 km) may be used to scope whether an assessment is needed, but the quantification rests on the model, not the distance. An independent wake study is required where a third-party array lies within the screening distance. A wake assessment prepared within a regulatory environmental-impact-assessment process may serve as the independent wake study where it applies a model family of this section, identifies the affected third-party arrays and quantifies the generation loss. Where the competent authority publishes conclusions only, the activity developer shall obtain the underlying model documentation or commission a supplementary independent study confined to the unquantified elements.
Value(s) applied	• Proximity threshold: 5 km for ONSHORE arrays; 100 km for OFFSHORE arrays. Beyond these distances, wake effects on a third-party array are deemed negligible and $LE_{wake} = 0$. The onshore screen reflects the shorter persistence of onshore wakes; the offshore screen reflects documented far-field persistence of offshore wakes under stable stratification (45 to 70 km in situ). • Acceptable wake models: Jensen / PARK, eddy-viscosity, or computational fluid dynamics (CFD) • An independent environmental impact assessment or wake study is required where a third-party array lies within the applicable threshold
Source of data	*Onshore far-field wake effects and their economic consequences:* Lundquist et al. (2019), Nature Energy 4, 26-34. Offshore far-field persistence: Platis et al. (2018), Scientific Reports 8:2163 (in situ wakes of 45 to 70 km under stable stratification, wind-speed deficits to 40 per cent) and Cañadillas et al. (2020), Wind Energy (wake recovery against engineering models), with Cañadillas et al. (2022), Wind Energy Science 7, 1241-1262 supporting.

Choice of data / justification	Wake losses depend on hub height, rotor characteristics, array geometry and the wind/tidal resource, none of which a fixed distance captures; a distance buffer alone can both over- and under-state the effect. Offshore, the low surface roughness of the marine boundary layer allows wakes to persist far further than onshore, which the screening distances reflect. Developers of adjacent arrays typically already hold such models.
Comments	Not applied where the affected array is itself a registered crediting activity (its loss is accounted within its own boundary; $LEwake = 0$).

A 1.15| References

Astolfi, D., & Pandit, R. (2022). Wind turbine performance decline with age. Energies, 15(14), 5225. https://doi.org/10.3390/en15145225

Benini, G., & Cattani, G. (2022). Measuring the long run technical efficiency of offshore wind farms. Applied Energy, 308, 118218. https://doi.org/10.1016/j.apenergy.2021.118218

Cañadillas, B., Beckenbauer, M., Trujillo, J. J., Dörenkämper, M., Foreman, R., Neumann, T., & Lampert, A. (2022). Offshore wind farm cluster wakes as observed by long-range-scanning wind lidar measurements and mesoscale modeling. *Wind Energy Science, 7*(3), 1241–1262. https://doi.org/10.5194/wes-7-1241-2022

Cañadillas, B., Foreman, R., Barth, V., Siedersleben, S., Lampert, A., Platis, A., Djath, B., Schulz-Stellenfleth, J., Bange, J., Emeis, S., & Neumann, T. (2020). Offshore wind farm wake recovery: Airborne measurements and its representation in engineering models. *Wind Energy, 23*(5), 1249–1265. https://doi.org/10.1002/we.2484

European Network of Transmission System Operators for Electricity. (2019). *Hydropower modelling: New database and methodology*. https://eepublicdownloads.blob.core.windows.net/public-cdn-container/clean-documents/sdc-documents/MAF/2019/Hydropower_Modelling_New_database_and_methodology.pdf

Germer, S., & Kleidon, A. (2019). Have wind turbines in Germany generated electricity as would be expected from the prevailing wind conditions in 2000-2014? PLoS ONE, 14(2), e0211028. https://doi.org/10.1371/journal.pone.0211028

Gold Standard. (2026). Embodied emission factors for generation technologies: Background document to G-RESET Annex 1 A.1.4 (Version 1.0). Gold Standard Foundation.

Gueymard, C. A., & Wilcox, S. M. (2011). Assessment of spatial and temporal variability in the US solar resource from radiometric measurements and predictions from models using ground-based or satellite data. Solar Energy, 85(6), 1068–1084. https://doi.org/10.1016/j.solener.2011.02.030

Hamilton, S. D., Millstein, D., Bolinger, M., Wiser, R., & Jeong, S. (2020). How does wind project performance change with age in the United States? Joule, 4(5), 1004-1020. https://doi.org/10.1016/j.joule.2020.04.005

Intergovernmental Panel on Climate Change. (2006). 2006 IPCC guidelines for national greenhouse gas inventories (Vol. 2: Energy; Vol. 4: AFOLU). Institute for Global Environmental Strategies.

Intergovernmental Panel on Climate Change. (2011). Renewable energy sources and climate change mitigation: Special report of the Intergovernmental Panel on Climate Change (O. Edenhofer, R. Pichs-Madruga, Y. Sokona, K. Seyboth, P. Matschoss, S. Kadner, T. Zwickel, P. Eickemeier, G. Hansen, S. Schlömer, & C. von Stechow, Eds.). Cambridge University Press.

Intergovernmental Panel on Climate Change. (2013). Climate change 2013: The physical science basis. Contribution of Working Group I to the Fifth Assessment Report (Ch. 8, Appendix 8.A, Table 8.A.1). Cambridge University Press.

Jordan, D. C., & Kurtz, S. R. (2013). Photovoltaic degradation rates - An analytical review. Progress in Photovoltaics: Research and Applications, 21(1), 12-29. https://doi.org/10.1002/pip.1182

Jordan, D. C., Kurtz, S. R., VanSant, K., & Newmiller, J. (2016). Compendium of photovoltaic degradation rates. Progress in Photovoltaics: Research and Applications, 24(7), 978-989. https://doi.org/10.1002/pip.2744

Le Varlet, T., Schmidt, O., Gambhir, A., Few, S., & Staffell, I. (2020). Comparative life cycle assessment of lithium-ion battery chemistries for residential storage. Journal of Energy Storage, 28, 101230. https://doi.org/10.1016/j.est.2020.101230

Lorentzen, S., Osmundsen, P., & Lu, L. (2024). Immature offshore wind technology: UK life cycle capacity factor analysis. *Wind Energy, 27*(10), 1095–1110. https://doi.org/10.1002/we.2939

Lundquist, J. K., DuVivier, K. K., Kaffine, D., & Tomaszewski, J. M. (2019). Costs and consequences of wind turbine wake effects arising from uncoordinated wind energy development. Nature Energy, 4(1), 26-34. https://doi.org/10.1038/s41560-018-0281-2

Olauson, J., Edstrom, P., & Ryden, J. (2017). Wind turbine performance decline in Sweden. Wind Energy, 20(12), 2049-2053. https://doi.org/10.1002/we.2132

Peiseler, L., Schenker, V., Schatzmann, K., Pfister, S., Wood, V., & Schmidt, T. (2024). Carbon footprint distributions of lithium-ion batteries and their materials. Nature Communications, 15, 10301. https://doi.org/10.1038/s41467-024-54634-y

Platis, A., Siedersleben, S. K., Bange, J., Lampert, A., Bärfuss, K., Hankers, R., Cañadillas, B., Foreman, R., Schulz-Stellenfleth, J., Djath, B., Neumann, T., & Emeis, S. (2018). First in situ evidence of wakes in the far field behind offshore wind farms. *Scientific Reports, 8*, Article 2163. https://doi.org/10.1038/s41598-018-20389-y

Pryor, S. C., Shepherd, T. J., & Barthelmie, R. J. (2018). Interannual variability of wind climates and wind turbine annual energy production. *Wind Energy Science, 3*(2), 651–665. https://doi.org/10.5194/wes-3-651-2018

Roy, R., & Pearce, J. M. (2023). Is small or big solar better for the environment? Comparative life cycle assessment of solar photovoltaic rooftop vs. ground-mounted systems. The International Journal of Life Cycle Assessment. https://doi.org/10.1007/s11367-023-02254-x

Smith, B. L., Sekar, A., Mirletz, H., Heath, G., & Margolis, R. (2024). An updated life cycle assessment of utility-scale solar photovoltaic systems installed in the United States (NREL/TP-7A40-87372). National Renewable Energy Laboratory.

Staffell, I., & Green, R. (2014). How does wind farm performance decline with age? Renewable Energy, 66, 775-786. https://doi.org/10.1016/j.renene.2013.10.041

United Nations Framework Convention on Climate Change. (2026). Mechanism methodology: Electricity generation from renewable sources connected to an electricity system (A6.4-AMM-003, Version 01.0). Article 6.4 Supervisory Body.

NREL note: on 1 December 2025 the US Department of Energy renamed the National Renewable Energy Laboratory the National Laboratory of the Rockies (NLR). NREL-authored sources in this methodology are cited under the name under which they were published, per referencing convention; only the associated URLs may have migrated to the nlr.gov domain.

Annex -2|Tiered Temporal Accounting and Storage Reconciliation

A 2.1| Purpose

A 2.1.1| This Annex sets out the temporal emission-factor framework for energy storage (Module ST, and storage flexibility under in Modules CG and VPP); the charge-discharge attribution and the monitoring-period conservativeness floor; the formal override of the A6.4-AMT-007 build-margin weighting for storage (A.2.3); and the peer-reviewed evidence base. It also governs the temporal treatment of pumped hydro storage (PHS) charging.

A 2.2| Why storage requires marginal, temporally-resolved accounting

a.| **Energy storage is not inherently low-carbon:** Storage neither generates energy nor is intrinsically clean: it returns less energy than it absorbs (round-trip losses) and shifts demand between hours with different generation mixes. Whether a charge-discharge cycle reduces or increases emissions depends entirely on the carbon intensity of the generation displaced at discharge relative to that consumed at charge, adjusted for losses. The seminal system study found that 90%-efficient storage operating for arbitrage would have increased CO_2 emissions in essentially all United States wholesale markets analysed, with net emissions of 104-407 kg CO_2 per MWh delivered, and that only storage approaching 100% round-trip efficiency could reduce system emissions (Hittinger & Azevedo, 2015). The result is insensitive to fuel-price and generation-mix assumptions and has been corroborated for other systems (Hittinger & Azevedo, 2017; Tang et al., 2022).

b.| **Implication for crediting**: Crediting storage against an annual average grid emission factor would systematically over-credit, ignoring both the timing of charge and discharge and the round-trip-loss penalty. A methodology shall (i) value charge and discharge at the emission factor of the generation that actually responds at the margin in each interval, and (ii) ensure that an asset whose net operation increases system emissions earns no credits.

c.| **Average versus marginal emission factors:** A change in supply or demand - such as a storage charge or discharge - is met by the specific generators operating at the margin, captured by the marginal emission factor rather than the system-average factor. In the first systematic estimation for the U.S. system, using regressions of hourly generation and emissions data, Siler-Evans, Azevedo, and Morgan (2012) found that average factors may grossly misestimate the emissions avoided (or caused) by an intervention, and that marginal factors are the appropriate signal for demand- or supply-side changes, explicitly including energy storage. The same conclusion has been

reached across regional systems (Thind et al., 2017; Gai et al., 2019) and for developing-country grids (Sengupta et al., 2022), and the choice of model and method is itself recognised to affect the result materially (Ryan et al., 2016).

d.| **Short-run versus long-run - what this methodology does and does not credit:** Marginal factors estimated from historical dispatch are short-run: they reflect the prevailing fleet and do not capture structural decarbonisation, which is described by long-run marginal factors (Hawkes, 2014). The operating-margin signal therefore values the activity's actual hour-by-hour displacement only; it does not capture longer-run structural effects, in particular storage's capacity to improve the economics of variable renewables and thereby support additional renewable build. The ambition Downward Adjustment Factor (Section 7.3) contracts the crediting baseline toward the host Party's long-term trajectory, but it is an ambition mechanism and is not a correction that converts the short-run signal into a long-run structural estimate. The methodology's position is that storage's structural contribution, while real, cannot at present be attributed to an individual asset on an auditable basis and that crediting it would increase issuance on a speculative footing; it is therefore deliberately not credited: the conservative treatment. Marginal factors also vary strongly by hour, season and location (Siler-Evans et al., 2012; Thind et al., 2017), which is why the methodology resolves them in time (A.2.4-A.2.5) and, where available, in space. Because high-resolution dispatch data are structurally unavailable in many developing-country grids, the framework permits a conservative load-block proxy (Tier 1) until hourly data systems mature (A.2.5).

A 2.3| Relationship to A6.4-AMT-007 and build-margin override

A6.4-AMT-007 retains the combined-margin approach, comprising an operating margin (the generation that responds at the margin) and a build margin (the average intensity of new capacity that would likely be built in the absence of the activity). The two margins serve different physical effects, and the methodology applies them accordingly:

a.| **Net-new generation (Modules GG and BO, grid displacing generation under CG and VPP)** displaces marginal operation and defers new-build capacity, and combined margin is therefore applied as grid-displacing output. Module CG displacing on-site fossil generation uses the captive generator's emission factor (eq 9–10) (Section 7).

b.| **Energy storage (Module ST, and storage flexibility in Modules CG and VPP)** shifts energy between hours. The standard build margin represents the average intensity of new generating capacity the activity defers: a fossil-capacity-deferral effect. Energy-shifting storage does not defer new fossil capacity: it adds no firm supply, it

moves pre-existing energy in time, and its net annual energy demand after round-trip losses is small. The standard build-margin construct therefore does not apply to storage, and this methodology formally overrides the A6.4-AMT-007 default for storage: the build-margin weight w_{BM} is set to 0 and the operating-margin weight w_{OM} to 1. This is a methodology-specific deviation from a referenced tool, expressly stated under Section 2 (order of precedence).

A 2.3.2| **Basis for w_{BM} = 0, and a flagged limitation.** Two points are distinguished. First, storage does not produce the fossil-capacity-deferral benefit the standard build margin measures, so setting w_{BM} = 0 removes a term that would otherwise credit a benefit the asset does not provide. Second, storage does have a separate structural effect: by raising prices in renewable-abundant hours it can improve the economics of variable renewables and support additional renewable build, but this is not the standard build margin, cannot at present be attributed to an individual storage asset on an auditable basis, and would increase issuance if credited; consistent with conservativeness as the tie-breaker, it is not credited. The short-run marginal-emissions literature (Hittinger & Azevedo, 2015; Siler-Evans et al., 2012) is cited elsewhere in this Annex to explain why storage arbitrage is not inherently emission-reducing and must be reconciled against the operating margin; it is not relied upon as the basis for excluding the build margin, since that literature addresses short-run impacts only.

A 2.3.3| **Co-located generation safeguard (anti-transmutation).** Where storage charges from co-located generation rather than from the electricity system, the emission reduction credited to the discharge of that energy shall not exceed the emission reduction the same generation would have earned had it been supplied directly to the system at the combined margin:

$$ER_{sto,co-located,y} = MIN\left[\sum_h \left(EG_{discharge,h,y} \times EF_{grid,OM,h,y} \times \left(1 - DAF_y\right)\right), \sum \left(\mathrm{EG}_{\mathrm{charged,co-located,y}} \times \mathrm{EF}_{\mathrm{grid,CM,y}} \times \left(1 - DAF_y\right)\right)\right]$$

A 2.3.4| This prevents the activity from **transmuting** generation output from the combined-margin factor it would earn as direct supply into a higher operating-margin-only factor by routing it through storage — a gaming route in which superficial time-shifting inflates the credit of the underlying generation. Grid-charged storage is unaffected (there is no co-located generation credit to protect).

A 2.3.5| Temporal emission factors are determined from, in descending order of preference: published marginal-emissions or dispatch data at hourly or finer resolution; system-operator generation-mix data at hourly resolution; and, where neither is structurally available, the Tier 1 time-of-use proxy of this Annex. An activity shall apply the highest tier structurally available in its market at validation, and shall upgrade at higher tier on the timing set out in Section A 2.5.1.

A 2.4| Tier 2 - Hourly marginal accounting (applies where data permit)

A 2.4.1| Under Tier 2, the operating-margin emission factor $EF_{grid,OM,h,y}$ is the short-run marginal emission factor of the electricity system in settlement interval h, derived using the methods permitted by A6.4-AMT-007 for the operating margin (paragraph 59). Where hourly resolution is required, the Dispatch Data Operating Margin shall be used, calculated from the actual operational dispatch order, the marginal (top-x%) units dispatched in each interval, in accordance with paragraphs 65–72 of A6.4-AMT-007. Hourly operating-margin factors published by the TSO or a competent national authority may be used where derived consistently with A6.4-AMT-007. The method, data and period shall be documented for the VVB.

A 2.4.2| **Data sources and verifiability**. The operating-margin factor shall be derived by the top-x% dispatch-data method of A6.4-AMT-007 from primary, auditable inputs — continuous-emissions-monitoring datasets and system-operator dispatch and fuel-mix records. Third-party or proprietary marginal-emissions data services shall not be used as a source unless the provider's method is demonstrably the A6.4-AMT-007 method (or a more conservative equivalent), is transparent, and is independently verifiable by the VVB; opaque or proprietary load-proxy methods do not qualify. "Infinitesimal" or high-frequency system-operator marginal signals shall not be used: they vary widely, are prone to non-physical spikes and negative excursions that correspond to no real generator, and are frequently post-processed in undisclosed ways, so they are not a meaningful basis on which to credit storage operation. A factor published by the system operator or a competent national authority may be used only where it is derived consistently with the A6.4-AMT-007 top-x% method and this is documented. Factors shall match the metering settlement interval (hourly or finer) and, where the operator publishes nodal/zonal factors, the relevant node or zone. Where the marginal generator in an interval cannot be reliably identified, the conservative bound applies - the lower plausible factor on the discharge side (Case 2) and the higher on the charge side (Case 1).

A 2.5| Tier 1 - Time-of-Use proxy (only where hourly data are unavailable)

A 2.5.1| Where the host system does not publish, and the developer cannot reliably derive, hourly marginal factors, the operating margin is resolved into standardised daily load blocks. Tier 1 is transitional: an activity applying it shall upgrade to Tier 2 at the next crediting period renewal or within three years of validation, whichever is earlier, in accordance with the data-readiness pathway of the GS4GG Technical addendum to the A6.4 Grid Emission Factor Tool (Section 3.2; Section 17). Where the host system does not then publish or supply the necessary data, Tier 1 continues and the upgrade applies at the first verification after the data become available

a.| **Load-block definition:** Three blocks from the host system's chronological load-duration curve for the reference period: Peak (highest-load third of hours), Off-peak (lowest third) and Shoulder (the remaining third); or the system operator's published time-of-use windows where these exist.

b.| **Block factor assignment:** The A6.4-AMT-007 operating margin is allocated to each block using the system load profile and merit order, so peak blocks carry the higher-emitting marginal units and off-peak blocks the baseload margin. The derivation weights the hourly (or finest available) operating-margin generation and emissions data of A6.4-AMT-007 by the hours falling in each block, using the block definitions of the system operator or, absent such definitions, the block boundaries documented in the PDD; the derivation is disclosed to the VVB in full.

c.| **Conservativeness discount (DF_{ToU})**: On the discharge (baseline) side, the block operating-margin factor is multiplied by DF_{ToU} = 0.90 (a 10% reduction) to account for the loss of temporal resolution; on the charge (activity) side, the maximum operating-margin factor within the block is applied. The 0.90 default is conservative; it ensures Tier 1 does not over-credit relative to a resolved Tier 2 accounting, in which the correlation between dispatch and carbon intensity that makes arbitrage beneficial is preserved.

A 2.6| Curtailment exception.

A 2.6.1| Where the storage verifiably charges from co-located generation that would otherwise have been curtailed, the charging factor is zero in that interval under either tier. To be deemed verifiable, the activity developer shall provide irrefutable digital telemetry demonstrating any of the following for the charging interval:

a.| **Instruction.** A timestamped active-power curtailment instruction from the Transmission/Distribution System Operator or the automated plant controller.

b.| **Price.** A published wholesale/nodal price at or below a defined short run floor: a small positive floor reflecting the system’s non-zero short-run marginal cost (for example, the short-run marginal cost of the cleanest dispatchable unit in merit order), documented and justified to the VVB. This replaces a strict “≤ 0” test, since real markets rarely print exactly zero yet a price below short-run marginal cost still signals surplus that would be spilled. The short-run floor is determined system-specifically as the published must-run or floor price of the system operator or, where none is published, the documented short-run marginal cost of the marginal must-run unit, evidenced from operator publications or regulatory filings and fixed in the PDD.

c.| **Physical would-be-curtailment (for systems without published locational prices)**. Metered co-located renewable generation

exceeding on-site load plus available export capacity in the charging interval, such that the charged energy could not have been exported and would physically have been spilled. The generation, load and export-capacity data shall be separately metered and auditable.

A 2.6.2| Self-declared economic curtailment without one of (a)–(c) is ineligible. A storage asset co-located and DC-coupled to a renewable plant and technically restricted from grid charging incurs zero charging emissions by construction. Evidence streams (a) to (c) may be combined where each stream is independently auditable and the combination is documented in the monitoring plan; where streams conflict for an interval, the conservative outcome (charging treated as grid-sourced at the applicable factor) applies.

A 2.7| Charge-discharge attribution (dynamic carbon pool)

A 2.7.1| Discharged energy is linked to its charging origin using a dynamic, energy-weighted rolling average - a continuous carbon pool - rather than a discrete batch (first-in-first-out) method, which is brittle to parasitic loads, self-discharge and high-frequency micro-cycling and is difficult for a VVB to audit. The carbon intensity of the stored-energy pool, EF_{pool}, is updated at each charging interval h:

$$EF_{pool} = \left(E_{stored,h-1} \times EF_{pool,h-1} + EC_{charge,h} \times EF_{grid,charge,h}\right) / \left(E_{stored,h-1} + EC_{charge,h}\right)$$

A 2.7.2| Every discharge interval draws energy at the prevailing pool intensity ($EF_{\text{grid,charge,attr,h,y}} = EF_{pool,h}$), eliminating directional batch manipulation and accommodating parasitic losses. The pool is carried forward continuously across settlement and billing periods, reflecting the physical energy inventory; no discrete daily accounting window is applied.

where:

Symbol	Description	Unit
$EF_{pool,h}$	Energy-weighted carbon intensity of the stored-energy pool after interval h	tCO₂/MWh
$E_{stored,h-1}$	Energy in the pool at the end of the previous interval	MWh
$EC_{charge,h}$	Energy charged in interval h (metered gross)	MWh
$EF_{grid,charge,h}$	Charging emission factor in interval h (A.2.4/A.2.5; zero under A.2.6)	tCO₂/MWh
$EF_{grid,charge,attr,h,y}$	Charging factor attributed to energy discharged in interval h ($EF_{pool,h}$) [GR-M15]	tCO₂/MWh

A 2.8| Per-interval reconciliation and the monitoring-period floor:

A 2.8.1| The net mitigation of Module ST is calculated per interval but floored at zero only at the monitoring-period aggregate, so that emission-increasing (perverse) cycles offset emission-reducing cycles and the asset's true net atmospheric impact is preserved (Section 10.2, eq. 43):

$$ER_{sto,y} = MAX(0, \sum_h (EG_{discharge,h,y} \times EF_{grid,OM,h,y} \times (1 - DAF_y) - EF_{grid,charge.h,y} \times EF_{grid,charge,attr,h,y} \div RTE)\ )$$ Eq 43, restated

A 2.8.2| **Monitoring-period (not per-interval) floor.** The MAX (0, ...) operator is applied to the sum over the monitoring period, not to each interval. A storage asset whose net operation over the period increases system emissions therefore earns zero credits, rather than being credited for its emission-reducing intervals while its emission-increasing intervals are ignored. This preserves the net atmospheric flux (conservative accounting) and creates a direct incentive for carbon-optimised dispatch.

A 2.8.3| **Ambition adjustment (applied once).** The ambition factor (1 − DAF_y) is applied to the **discharge-displacement side only**, and this is storage's single DAF application (it is not carried from Section 7 for storage, because ER_{ST} is computed net here).

A 2.8.4| Round-trip-loss term. Because more energy is charged than discharged, charging emissions per unit discharged are $EF_{grid,charge,attr,h,y}/RTE$. This operationalises the Hittinger & Azevedo (2015) result: a genuine reduction requires the discharge-time displacement to exceed the loss-adjusted charging intensity.

A 2.8.5| Scope of eq 43. Equation 43 isolates the arbitrage reconciliation only. Annual activity emissions - fire-suppression-agent release (AE_{fss}) and pumped-hydro reservoir emissions ($AE_{hp,PHS}$) - are excluded here and are deducted at the global activity level in Section 10.

A 2.9| Worked example

A 2.9.1| A storage asset (round-trip efficiency RTE = 0.85) operates two representative daily cycles, each discharging 100 MWh; the Downward Adjustment Factor is set to zero for illustration. Operating-margin factors are in tCO_2/MWh.

Cycle	Charge EF	Discharge EF_{OM}	Discharged	EFch / RTE	Interval net (tCO_2e)
1	0.25	0.75	100	0.294	+45.6
2	0.80	0.40	100	0.941	-54.1

A 2.9.2| Scenario A - price-optimised (carbon-blind) dispatch: Monitoring-period aggregate = 45.6 + (-54.1) = -8.5 tCO_2e -> $ERST, y = MAX(0, -8.5) = 0$. The asset is a net emitter over the period (Cycle 2 charged from a high-carbon margin, e.g. coal ramping, and discharged into a cleaner interval; after round-trip losses it increased emissions). Because the perverse cycle is allowed to offset the beneficial one, the asset earns zero credits - the correct outcome for an activity that, on net, warmed the climate.

A 2.9.3| Scenario B - carbon-optimised dispatch. To earn issuance, the developer shall dispatch to minimise emissions - charging only when the marginal factor is low and discharging only when it is high. If both cycles resemble Cycle 1 (+45.6 each), the monitoring-period aggregate is +91.2 tCO_2e and

$ER_{ST,y}$ = 91.2. The floor therefore forces carbon-optimised operation: only an asset that reduces net system emissions is credited, and only for its true net reduction.

A 2.10| References

Gai, Y., Wang, A., Pereira, L., Hatzopoulou, M., & Posen, I. D. (2019). Marginal greenhouse gas emissions of Ontario's electricity system and the implications of electric vehicle charging. Environmental Science & Technology, 53(13), 7903-7912. https://doi.org/10.1021/acs.est.9b01519

Hawkes, A. D. (2010). Estimating marginal CO_2 emissions rates for national electricity systems. Energy Policy, 38(10), 5977-5987. https://doi.org/10.1016/j.enpol.2010.05.053

Hawkes, A. D. (2014). Long-run marginal CO_2 emissions factors in national electricity systems. Applied Energy, 125, 197-205. https://doi.org/10.1016/j.apenergy.2014.03.060

Hittinger, E. S., & Azevedo, I. M. L. (2015). Bulk energy storage increases United States electricity system emissions. Environmental Science & Technology, 49(5), 3203-3210. https://doi.org/10.1021/es505027p

Hittinger, E., & Azevedo, I. M. L. (2017). Estimating the quantity of wind and solar required to displace storage-induced emissions. Environmental Science & Technology, 51(21), 12988-12997. https://doi.org/10.1021/acs.est.7b03286

Ryan, N. A., Johnson, J. X., & Keoleian, G. A. (2016). Comparative assessment of models and methods to calculate grid electricity emissions. Environmental Science & Technology, 50(17), 8937-8953. https://doi.org/10.1021/acs.est.5b05216

Sengupta, S., Spencer, T., Rodrigues, N., Pachouri, R., Thakare, S., Adams, P. J., Tongia, R., & Azevedo, I. M. L. (2022). Current and future estimates of marginal emission factors for Indian power generation. Environmental Science & Technology, 56(13), 9237-9250. https://doi.org/10.1021/acs.est.1c07500

Siler-Evans, K., Azevedo, I. L., & Morgan, M. G. (2012). Marginal emissions factors for the U.S. electricity system. Environmental Science & Technology, 46(9), 4742-4748. https://doi.org/10.1021/es300145v

Siler-Evans, K., Azevedo, I. L., Morgan, M. G., & Apt, J. (2013). Regional variations in the health, environmental, and climate benefits of wind and solar generation. Proceedings of the National Academy of Sciences, 110(29), 11768-11773. https://doi.org/10.1073/pnas.1221978110

Tang, Y., Li, Y., Yuan, X., Pimm, A., Cockerill, T. T., Wang, Q., & Ma, Q. (2022). Estimation of emission factors from purchased electricity for European countries: Impacts on emission reduction of electricity storage. Environmental Science & Technology, 56(8), 5111-5122. https://doi.org/10.1021/acs.est.1c06490

Thind, M. P. S., Wilson, E. J., Azevedo, I. L., & Marshall, J. D. (2017). Marginal emissions factors for electricity generation in the Midcontinent ISO. Environmental Science & Technology, 51(24), 14445-14452. https://doi.org/10.1021/acs.est.7b03047

Annex -3|Embodied Emissions: Life-Cycle Assessment Methodology

A 3.1| Purpose

A 3.1.1| This Annex sets out the life-cycle-assessment (LCA) basis for the embodied-emissions leakage term (Section 9.4, equations 35 to 37). It covers the rationale for accounting embodied emissions as leakage (A 3.2); the system boundaries (A 3.3); the derivation of the default factors in Annex 1, Sections A 1.4 (generation) and A 1.5 (storage) (A 3.4 and A 3.5); amortisation within the crediting period (A 3.6); conservativeness (A 3.7); displaced-fleet symmetry (A 3.8); activity-specific factors (A 3.9); and the review of the defaults (A 3.10). References are listed in Section A 3.11.

A 3.2| Rationale: embodied emissions as leakage

A 3.2.1| Renewable generation and storage assets emit little or nothing during operation, but their construction embeds significant greenhouse-gas emissions in the manufacture of material-intensive hardware - photovoltaic modules, wind-turbine steel and composites, battery cells, marine converters - together with the mining and processing of their input materials. For these technologies, life-cycle GHG emissions are dominated not by operation but by the upstream production stages (Hsu et al., 2012; Dolan & Heath, 2012; Peiseler et al., 2024).

A 3.2.2| These production emissions occur predominantly outside the activity's spatial boundary, and typically in other jurisdictions (the location of cell, module and turbine manufacture). They are therefore correctly classified as leakage - emissions occurring outside the activity boundary that are attributable to the activity - rather than as activity emissions. Omitting them would overstate the net mitigation of material-intensive activities, most acutely for storage and solar. Their mandatory inclusion (Section 9) is consistent with the GS4GG Requirements for Addressing Leakage and corrects a recognised gap in legacy grid-renewable methodologies, which neglect upstream and construction emissions.

A 3.3| LCA framework and system boundaries

A 3.3.1| Life-cycle assessment under this methodology follows the principles and requirements of ISO 14040 and ISO 14044 and, for product carbon footprints, ISO 14067. Life-cycle stages are referenced using the modular framework of EN 15804 (European Committee for Standardization, 2012):

a.| A1-A3 (product / cradle-to-gate): raw-material supply, transport, and manufacturing - 'embodied' stage in the strict sense.

b.| A4-A5 (construction): transport to site and installation.

c.| B1-B7 (use): operation, maintenance and operational energy over the service life.

d.| C1-C4 (end of life): deconstruction, transport, waste processing and disposal.

e.| D (beyond the system boundary): reuse, recovery and recycling benefits.

A 3.3.2| The embodied emission factors cover the following stages:

a.| **Generation (Section A.1.4) and pumped hydro storage (Section A 1.5):** manufacture (A1 to A3), transport and installation (A4 to A5) and end-of-life (C1 to C4), consistent with EN 15804, excluding the burdens of recovering secondary materials beyond the end-of-waste state. Operation, maintenance and replacement (B1 to B7) are excluded. Reservoir emissions, geothermal non-condensable gases and working fluids, and the supply of biomass, biogas and landfill-gas feedstock are excluded, being accounted for under Sections 5.1 and 8 or under an Accompanying Methodology (Annex 5).

b.| **Electrochemical storage (Section A 1.5):** cradle-to-gate (A1 to A3) cell and pack values plus a balance-of-plant adder. Cell-production datasets are A1 to A3 by construction; the adder (enclosure, thermal management, power-conversion systems) extends the boundary to the utility-scale system.

A 3.3.3| **Module D (recycling benefits) is not applied**: no credit is taken for avoided future emissions from end-of-life material recovery. This is conservative. The End-of-Life Plan required by Section 3.2 is a physical-recycling safeguard, not a GHG credit, and does not interact with the leakage accounting.

A 3.4| Derivation of the generation default factors

A 3.4.1| The factors in Section A 1.4, and the pumped hydro storage factor in Section A 1.5, are derived from life-cycle assessments published from 2020 onwards. Where a class had fewer than five such studies, studies from 2015 onwards were added. For hydropower and pumped hydro storage, whose emissions are dominated by civil works, earlier inventories were admitted. Each study was restated to the boundary of Section A 3.3 and converted to tonnes of CO_2e per MW of installed capacity using its own yield and lifetime.

A 3.4.2| Each default is the 75th percentile of a lognormal distribution fitted to the studies of its class, one value per study, rounded up to the nearest 10. Embodied emissions are therefore likely (probability of at least 75 per cent) not to exceed the default. Where a class has fewer than five studies, the spread is taken from the classes that have five or more. Crystalline-silicon module studies are weighted by each manufacturing region's share of global module production (IEA PVPS, 2025). The lognormal treatment follows IPCC (2006, Vol. 1, Ch. 3).

A 3.4.3| A technology is divided into classes only where the class can be verified from the design documents, each class has at least five studies, and the class

medians differ by more than 25 per cent. Physically distinct designs whose medians differ by more than 50 per cent form their own class with fewer studies.

A 3.4.4| The defaults are conservative default deductions within the meaning of GS4GG PAA MS400-05, Section 7.1.5 (Gold Standard, 2025). They are expressed as GWP100. The source studies use IPCC AR5 or AR6 characterisation factors; the footprints are dominated by CO_2 and are not re-characterised.

A 3.4.5| The evidence pooled, the conversion parameters and the derivation for each class are set out in Gold Standard (2026).

A 3.5| Derivation of the storage default factors

A 3.5.1| The storage cell/pack factors (Annex 1 Section A.1.5) are drawn from Peiseler et al. (2024), who develop a cost-based method to estimate cradle-to-gate carbon-footprint distributions (5^{th}, 50^{th} and 95^{th} percentiles) for LFP and NMC batteries, combining material emission curves (lithium, nickel, cobalt) with regionalised production. The study finds that material sourcing - especially nickel and lithium - dominates both the footprint and its variance, which is why a single median understates the risk for high-impact supply chains.

A 3.5.2| Two adjustments are applied (Annex 1 Section A.1.5): the 95^{th} percentile is taken as the conservative default for a leakage penalty (a median would reward high-carbon, e.g. coal-grid, supply chains with an unearned discount and erode the incentive to provide a verified EPC); and a balance-of-plant adder of 30 tCO_2e/MWh extends the cell-only boundary to the utility-scale system, supported by full-system LCAs in which peripheral components contribute materially (Le Varlet et al., 2020, report full residential systems of ~200 kg CO_2e/kWh of capacity). The BOP adder is conservative-low, as utility-scale systems share infrastructure across a larger capacity than residential systems.

A 3.6| Amortisation within the crediting period

A 3.6.1| **Principle.** To claim net emission reductions, the embodied (Scope 3) emissions attributable to the activity's hardware must be fully recovered - deducted - within the crediting period over which credits are issued. If embodied emissions were instead amortised over the full technical life (which may exceed the crediting period), only the within-period fraction would be netted against issued credits, and the issued credits would overstate the net reduction by the un-recovered remainder. The amortisation period is therefore $N = MIN(LT, L_{CP})$. (Section 9.4.3)

A 3.6.2| **Generation - fixed capacity annuity, decoupled from actual output:** Embodied emissions are a fixed manufacturing debt incurred before the plant operates. The total is set by installed capacity (eq. 36), so it does not depend on the yield forecast, and it is amortised linearly over N. Curtailment or under-performance in any year cannot reduce the annual deduction.

Worked example: generation capacity annuity

A 100 MW AC solar PV plant with 125 MWp DC of crystalline-silicon modules on standard mounting; LT = 30 years; L_{CP}= 15 years; $EF_{embodied,gen}$ = 1,000 tCO₂e/MWp.

Total embodied = 125 × 1,000 = 125,000 tCO₂e

Annual deduction = 125,000 / MIN (30, 15) = 125,000 / 15 = 8,333 tCO₂e per year, fixed

The 8,333 tCO₂e is deducted each year regardless of actual generation.

A 3.6.3| **Long-lived civil infrastructure**. For hydropower and pumped hydro storage, with technical lifetimes of 40 to 80 years, N equals the crediting period, so the full embodied footprint is recovered within it. Embodied emissions are incurred upfront, and generation after the crediting period earns no credits, so it cannot carry any of the embodied burden. Amortising over the technical lifetime would recover only about LCP/LT of the footprint within the credited years. For hydropower, the Section A 1.4 defaults recovered over 15 years correspond to roughly 30 to 35 gCO₂e/kWh at load factors of 35 per cent (run-of-river) and 45 per cent (new dam).

A 3.6.4| **Storage - capacity annuity plus augmentation:** Storage embodied emissions scale with installed capacity rather than throughput and are amortised as a straight-line capacity annuity over N (eq. 37). Capacity augmentations (cell-rack replacements) are amortised over the remaining crediting-period years and exclude the balance-of-plant adder. For pumped hydro storage, Cap_s is the installed turbine capacity (MW) and no augmentation term applies

A 3.6.5| **Augmentation treatment.** The augmentation term (i) uses the cell/pack emission factor only ($\boldsymbol{EF_{cell/pack}}$: LFP 69, NMC 115 tCO₂e/MWh), excluding the balance-of-plant adder, because replacing degraded cell racks does not remanufacture the enclosure, thermal-management or power-conversion systems; and (ii) is amortised over the remaining maximum-crediting-period years, $\boldsymbol{MAX(1, L_{CP} - y_{aug} + 1)}$, not charged in a single year, to prevent an 'augmentation shock' in which a large single-year deduction is washed out below the annual zero-floor (Section 10) and the unrecovered embodied vanishes.

Worked example - storage annuity and augmentation

A 50 MWh LFP system; $EF_{embodied,sto,s}$= 99 tCO2e/MWh (cell 69 + BOP 30); technical life LT = 12 years; L_{CP} = 15 -> N = min (12,15) = 12.

Base annuity = (50 × 99) / 12 = 4,950 / 12 = 412.5 tCO2e/yr

Augmentation, year 10, 30% of cells, cell/pack factor only (69):

AUG = (0.30 × 50 × 69) / max (1, 15-10+1) = 1,035 / 6 = 172.5 tCO2e/yr for years 10-15.

A 3.7| Conservativeness and data quality

a.| **Generation and pumped hydro storage:** defaults at the 75th percentile of the fitted distribution of hardware-only life-cycle studies, rounded up (Section A 3.4).

b.| **Electrochemical storage:** cradle-to-gate (A1 to A3) 95th-percentile cell/pack values plus a conservative-low balance-of-plant adder (Section A 3.5).

c.| Embodied emissions are charged as fixed annuities, independent of annual output.

d.| Recycling benefits (module D) are excluded. Augmentation uses the cell/pack factor only and is amortised over the remaining crediting period.

e.| An activity-specific value may replace a default only under Section A 3.9.

f.| Amortisation over N = MIN(LT, L_{CP}) recovers embodied emissions in full within the crediting period. The true-up of Section 9.5 applies on non-renewal or early cessation.

A 3.8| Displaced-fleet symmetry (cross-reference)

A 3.8.1| **Displaced-fleet symmetry:** The methodology deducts the activity's embodied emissions but does not credit the displaced fossil fleet's embodied (non-combustion) emissions. This is a deliberate conservative asymmetry; its direction and order of magnitude are quantified in **Annex 1 Section A.1.6** (the omitted avoided-fossil embodied is comparable to or larger than the renewable embodied deducted, so the omission understates the net reduction).

A 3.9| Activity-specific embodied emission factors

A 3.9.1| An activity may replace a default term in Annex 1, Section A 1.4, or a default in Section A 1.5, with a value taken from an eligible declaration for the equipment installed.

A 3.9.2| For solar PV modules, an eligible declaration replaces the module term only. The mounting and electrical, installation and transport, and end-of-life terms remain at their default values.

A 3.9.3| The following declarations are eligible, provided they meet the requirements of A 3.9.4:

a.| an environmental product declaration under ISO 14025, prepared under EN 15804 (+A1 or +A2), ISO 21930 or a product category rule for photovoltaic modules;

b.| a carbon footprint of product under ISO 14067;

c.| a carbon assessment certificate issued under a national procurement or certification scheme.

A 3.9.4| The declaration shall:

a.| have been verified by a third party independent of the manufacturer, either through external verification under the rules of an ISO 14025 programme operator or through verification of an ISO 14067 carbon footprint by a body accredited for that verification. A carbon footprint not yet verified may be used once it has been verified in this way. The verifying body may be the activity's VVB where it holds the relevant accreditation and carries out the verification as a separate engagement. Activity validation and verification do not replace this verification;

b.| have been verified within the five years before the date of the purchase order for the equipment;

c.| report the manufacturing stages (A1 to A3) separately, or report results by stage so that A1 to A3 can be isolated;

d.| report global warming potential over 100 years, as GWP-total under EN 15804+A2 or as GWP under EN 15804+A1 or ISO 14067, as reported and without re-characterisation;

e.| exclude credits for recycling (module D or equivalent);

f.| be expressed per Wp or kWp, or be convertible to that unit using the declared rated power or module efficiency (per kWh of rated energy capacity for battery cells or packs);

g.| cover the installed module model, or a product family or power range that includes it, from the same manufacturer.

A 3.9.5| Where a declaration covers several models, power classes or manufacturing sites, the highest declared value applies unless the purchase records identify the specific model and site. Where a declaration reports results based on both location-based and market-based electricity, the location-based result applies.

A 3.9.6| Where modules are procured from more than one manufacturer or model, the module term is the capacity-weighted average of the applicable values. Modules without an eligible declaration use the default module term.

A 3.9.7| Where an eligible declaration covering the installed equipment has been obtained and its value exceeds the corresponding default term, the declaration value shall be applied.

A 3.9.8| At validation, the activity developer shall provide the declaration, its verification statement, and the purchase order or supply contract identifying the manufacturer and model. At first verification, it shall provide delivery records showing that the installed equipment matches. The VVB confirms that the declaration meets A 3.9.4 and matches the installed equipment. Where the equipment has not been procured at validation, the default applies until this evidence is provided.

A 3.9.9| The PDD shall state, for each declaration applied, the declared value, the programme operator or verifying body, the registration or certificate number

where one exists, and the date of verification. The declaration and its verification statement shall be provided in full to the VVB.

A 3.9.10| For generation technologies other than solar PV, and for pumped hydro storage, the default may be replaced by one of the following for the installed plant:

a.| a verified environmental product declaration under ISO 14025; or

b.| a manufacturer's life-cycle assessment under ISO 14040 and ISO 14044 with independent critical review. The declaration or assessment shall cover the whole plant, or be combined with evidence for the remaining components. Its results shall be restated on the boundary of Section A 3.3: operation excluded, credits for recycling excluded, and end-of-life included. A 3.9.4(b) applies.

A 3.9.11| For electrochemical storage, an eligible declaration for the installed cells or packs that meets A 3.9.4 replaces the cell/pack term. The balance-of-plant adder remains at its default value.

A 3.10| Review of the default factors

A 3.10.1| The embodied default factors in Annex 1, Sections A 1.4 and A 1.5, shall be reviewed at least every three years from publication. A review shall be brought forward where IEA PVPS publishes carbon results for its 2026 photovoltaic life-cycle inventory, or where Gold Standard becomes aware of evidence that a default no longer reflects the current evidence base. Reviews apply the selection rules of Sections A 3.4 and A 3.5. The published defaults remain in force until the review is completed. Revisions enter through the Defaults Register with their derivation attached.

A 3.11| References

Dolan, S. L., & Heath, G. A. (2012). Life cycle greenhouse gas emissions of utility-scale wind power: Systematic review and harmonization. Journal of Industrial Ecology, 16(S1), S136-S154. https://doi.org/10.1111/j.1530-9290.2012.00464.x

European Committee for Standardization. (2012). EN 15804: Sustainability of construction works - Environmental product declarations - Core rules for the product category of construction products. CEN.

European Committee for Standardization. (2019). EN 15804:2012+A2:2019 Sustainability of construction works: Environmental product declarations: Core rules for the product category of construction products. CEN.

Gold Standard. (2025). Requirements for addressing leakage in methodologies (GS4GG PAA MS400-05, Version 1.0). Gold Standard Foundation.

Gold Standard. (2026). Embodied emission factors for generation technologies: Background document to G-RESET Annex 1 A.1.4 (Version 1.0). Gold Standard Foundation

Hsu, D. D., O'Donoughue, P., Fthenakis, V., Heath, G. A., Kim, H. C., Sawyer, P., Choi, J.-K., & Turney, D. E. (2012). Life cycle greenhouse gas emissions of crystalline silicon photovoltaic electricity generation: Systematic review and

harmonization. Journal of Industrial Ecology, 16(S1), S122-S135. https://doi.org/10.1111/j.1530-9290.2011.00439.x

IEA PVPS. (2025). Trends in photovoltaic applications 2025. IEA Photovoltaic Power Systems Programme, Task 1.

Intergovernmental Panel on Climate Change. (2006). 2006 IPCC guidelines for national greenhouse gas inventories: Volume 1. General guidance and reporting. IGES.

International Organization for Standardization. (2006a). ISO 14040:2006 - Environmental management - Life cycle assessment - Principles and framework. ISO.

International Organization for Standardization. (2006b). ISO 14044:2006 - Environmental management - Life cycle assessment - Requirements and guidelines. ISO.

International Organization for Standardization. (2006c). ISO 14025:2006 Environmental labels and declarations: Type III environmental declarations: Principles and procedures. ISO.

International Organization for Standardization. (2017). ISO 21930:2017 Sustainability in buildings and civil engineering works: Core rules for environmental product declarations of construction products and services. ISO.

International Organization for Standardization. (2018). ISO 14067:2018 Greenhouse gases: Carbon footprint of products: Requirements and guidelines for quantification. ISO.

Le Varlet, T., Schmidt, O., Gambhir, A., Few, S., & Staffell, I. (2020). Comparative life cycle assessment of lithium-ion battery chemistries for residential storage. Journal of Energy Storage, 28, 101230. https://doi.org/10.1016/j.est.2020.101230

Peiseler, L., Schenker, V., Schatzmann, K., Pfister, S., Wood, V., & Schmidt, T. (2024). Carbon footprint distributions of lithium-ion batteries and their materials. Nature Communications, 15, 10301. https://doi.org/10.1038/s41467-024-54634-y

Annex -4|Digital MRV and Telemetry Protocol

A 4.1| Purpose

A 4.1.1| This Annex specifies the digital measurement, reporting and verification (dMRV) and telemetry requirements referenced in Section 3.4 (dMRV readiness), Section 14.1.1 (c) and A 4.4 (the Conservative Replacement Rule) and Section 14 (monitoring and the GR-N/GR-M parameter). It operationalises those requirements as an auditable technical protocol.

A 4.2| Metering standards

A 4.2.1| **Accuracy (**Tiered by metering point**)**: Electricity generation, charging, discharging and captive consumption shall be measured with static (electronic) meters as follows:

a.| Above 1 MW per metering point: IEC 62053-22 accuracy class 0.2S or 0.5S or certified the national equivalent ;

b.| from 100 kW to 1 MW per metering point: class 0.5S, or class 1 with a 1.5 per cent conservativeness deduction applied to the metered quantity;

c.| below 100 kW per metering point: class 1, or class 2 with the [3] per cent deduction of A 4.5.1(a), in each case with reconciliation against settlement or billing data at each verification where such data exist.

At every tier, an instrument certified by the competent national metrology authority to an equivalent accuracy, calibration and traceability standard satisfies the class requirement. This paragraph is a specified deviation from AR 202 Section 5.1.1: where the enforced national standard prescribes a lower accuracy class than the applicable tier, the tier requirement prevails and is discharged either by the higher-class instrument or by the class-with-deduction route above. Existing certified meters of a transitioning activity are governed by the phased conformance of A 4.6.

A 4.2.2| **Architecture (proportionate to scale):** For each metering point above the utility-scale marker (5 MW generation or 5 MWh storage), and for standalone Modules ST and CG above that marker, metering shall be revenue-grade advanced metering infrastructure installed at the point of interconnection and at each charge, discharge and captive metering point. For smaller activities, a proportionate architecture (for example a programmable logic controller in place of a full SCADA system) is permitted, provided the applicable accuracy tier of A 4.2.1 is met. For aggregated distributed resources (Module VPP), and for Programmes of Activities aggregating distributed captive or small-scale generation (Section 16), the Aggregation Reconciliation Waiver applies (A.4.5).

A 4.2.3| **Bidirectional metering:** Bidirectional metering is required for storage and behind-the-meter/captive configurations; for Module CG, captive generation

and captive consumption shall each be metered bidirectionally at the relevant boundary (Section 14.1; parameter cards GR-M01, GR-M07, GR-M08).

A 4.2.4| **Instrument transformers:** Where current/voltage transformers are used, they shall meet the corresponding IEC 61869 (formerly IEC 60044) accuracy class and be included in the calibration programme (A.4.7).

A 4.2.5| **Resolution:** Generation and captive meters shall record at least hourly. Storage (Module ST, and storage flexibility in Modules CG and VPP) meters shall record at the settlement-interval resolution required by Tiered Temporal Accounting (Annex 2) - hourly or finer - with synchronised metered state of charge to support the rolling carbon pool (Annex 2. Section 2.7).

A 4.3| Telemetry and data architecture

A 4.3.1| **Automated acquisition.** Data shall be acquired automatically via SCADA (conforming to IEC 61850 where applicable) or authenticated application-programming-interface (API) integration; manual meter reading is not permitted for Modules ST, CG and VPP.

A 4.3.2| **Timestamping.** All records shall carry synchronised timestamps (UTC, or local time with a fixed UTC offset), aligned to the host system's settlement intervals, with clock synchronisation to a recognised time source.

A 4.3.3| **Completeness and integrity.** The data pipeline shall capture raw interval data and preserve it unaltered; all derived/aggregated values shall be reproducible from the raw data.

A 4.4| Conservative Replacement Rule (telemetry gaps)

A 4.4.1| Where metered data are missing for one or more intervals, the gap shall be handled conservatively - never by interpolation or omission (Section 10.2):

a.| **Baseline (revenue) side**: Electricity exported / generated / discharged in a gap interval is set to ZERO for that interval.

b.| **Activity (cost) side:** Electricity imported (charging, auxiliary) and fossil fuel consumed in a gap interval are set to their maximum plausible value (e.g., rated import capacity x interval duration; tank/throughput-bounded fuel).

c.| **Storage state of charge:** Where the state of charge is unknown across a gap, the energy discharged afterwards that cannot be attributed to a metered charge is treated as charged at the maximum plausible charging factor for the gap period (rolling pool, Annex 2 section 2.5).

d.| **Completeness threshold:** Data completeness shall be at least 95% of the expected metered intervals per data stream in any monitoring period. Where completeness falls below the threshold for a parameter material to the result, the affected output shall not be credited for that

period unless the developer demonstrates, to the VVB; the threshold, the maximum contiguous gap eligible for reconstruction, and any reconstruction method shall be documented. All gaps and their treatment shall be logged.

A 4.5| Aggregation Reconciliation Waiver (Module VPP and distributed PoAs)

A 4.5.1| For a VPP or a PoA of distributed captive or small-scale generation, aggregating a large number of distributed nodes, aggregated telemetry may be sourced from original-equipment-manufacturer or platform interfaces at IEC accuracy class 1 or 2, in place of the revenue-grade requirement (A.4.2) and the per-node Conservative Replacement Rule (A.4.4), subject to:

a.| a standardised conservative discount of 3% applied to the aggregated result, pinned to the meter-accuracy differential the waiver admits: platform/inverter telemetry at IEC 62053-21 class 1 or 2 (± 1% / ± 2%) in place of revenue-grade IEC 62053-22 class 0.5S (± 0.5%). A 3% haircut conservatively covers the worst permitted (class-2) error plus a margin for node-aggregation and time-synchronisation uncertainty. A larger discount may always be applied; a smaller one only where every aggregated node demonstrably meets a revenue-grade class and is reconciled. Because the settlement reconciliation below trues the aggregate up against settlement record, the discount is a conservativeness margin on the un-reconciled interim result, not the primary integrity control; and

b.| reconciliation of the aggregated result at each verification against an independent settlement record: system-operator settlement data where the configuration exports to the electricity system, or the utility invoice or net-metering statement where output is consumed behind the meter.

A 4.5.2| The waiver relaxes node-level accuracy while preserving aggregate integrity through the discount and the settlement reconciliation (Section 14.1).

A 4.6| Transition activities (phased dMRV)

A 4.6.1| An activity transitioning from a legacy framework whose installed metering does not yet meet the accuracy or telemetry requirements shall bring its metering into conformance under a phased-implementation schedule set out at validation, with full conformance by a defined date. Until then, the Conservative Replacement Rule (A.4.4) and the completeness threshold apply, and reductions are claimed only for conforming data streams (Section 14.1).

A 4.7| QA/QC, calibration and audit trail

a.| **Calibration:** All meters, transformers and sensors shall be calibrated and sealed at commissioning and re-calibrated at the manufacturer's or national-metrology-prescribed interval; the calibration scope

includes the instrument transformers in the metering chain (A.4.2). The calibration certificates shall be retained.

b.| **Validation and reconciliation:** Monitored quantities shall be reconciled against independent records (settlement statements, invoices, fuel-purchase records) at each verification; material discrepancies shall be investigated and resolved conservatively.

c.| **Tamper-evidence and access control:** Metering and data systems shall employ tamper-evident seals, role-based access control, and an immutable audit log of configuration changes and data edits.

d.| **Archiving:** All raw and processed monitoring data and supporting evidence shall be archived for at least two years after the end of the crediting period.

A 4.8| Cyber-integrity

A 4.8.1| Industrial control and data-acquisition systems shall apply recognised operational-technology security controls (e.g., IEC 62443), including network segmentation, authenticated access, integrity protection of transmitted data, and logging, commensurate with the scale of the activity. The integrity of the data underpinning issuance shall be demonstrable to the VVB.

A 4.9| Normative standards

A 4.9.1| IEC 62053-22 (static meters, classes 0.2S/0.5S); IEC 61869 series (instrument transformers); IEC 61850 (communication networks and systems for power utility automation); IEC 62443 series (security for industrial automation and control systems); and the prevailing GS4GG digital-MRV guidance.

Annex -5|Accompanying Methodologies Boundary and Transition Mapping

A 5.1| Purpose

A 5.1.1| This Annex implements the power-generation-component provision of Section 3.1 and the boundary and double counting rules of Sections 5.1 and 11.3. Where a combustion or waste-gas installation generates electricity and also delivers a distinct mitigation outcome (methane destruction, organic waste diversion), this methodology credits only the power-generation component; all other outcomes are credited under an Accompanying Methodology, with a boundary delineated so that no source, parameter or reduction is counted twice.

A 5.2| Register of recognised pairings

A 5.2.1| The following pairings are recognised. The register may be extended by Gold Standard; any approved GS4GG or Article 6.4 mechanism methodology that quantifies the non-power outcome may serve as the Accompanying Methodology, subject to the boundary rule (A.5.3).

Table 5.1. Recognised G-RESET / Accompanying Methodology pairings

Installation (Module GG/BO)	Non-power outcome → Accompanying Methodology	Power outcome credited under G-RESET
Landfill gas to power	Methane capture and destruction -> A6.4-AMM-001 (Flaring or use of landfill gas)	Displacement of grid/captive electricity by the LFG genset export (eq 1-2)
Biogas / anaerobic digestion to power	Methane avoidance / organic-waste diversion → applicable A6.4 or GS4GG manure/waste methodology	Displacement of grid/captive electricity by the biogas genset export
Biomass (residue) to power	Sustainable biomass / waste-diversion outcome → applicable biomass methodology (where claimed)	Displacement of grid/captive electricity by biomass generation
Waste-heat recovery to power	Recovered thermal-energy supply -> applicable WHR/efficiency methodology (where claimed)	Displacement of grid/captive electricity by WHR generation

A 5.3| Boundary Allocation and Reconciliation Table

A 5.3.1| For every pairing, the two methodologies shall partition the sources so that source, parameter and emission reduction is accounted under exactly one methodology. Every activity applying an Accompanying Methodology shall complete this table in the PDD, recording for each shared source/parameter its data stream, the governing equation, the metering point, the evidence and the responsible methodology.

Table 5.2. Source-by-source partition (illustrated for landfill gas to power)

Source / parameter	Data stream	Equation	Metering point	Evidence	Responsible methodology
Methane generation, capture and destruction (flaring/combustion)	CH_4 flow × CH_4 fraction	(Accompanying)	Flare / engine inlet	SCADA flow log; gas analysis	A6.4-AMM-001
Biogenic CO_2 from combustion of the captured gas	— (per IPCC)	(Accompanying)	Engine inlet	Gas composition	A6.4-AMM-001
Net electricity exported to the grid / captive load	Export meter	eq. 1–2	Interconnection	Settlement / revenue meter	G-RESET (Module GG)
Grid/captive emission factor of the displaced electricity	A6.4-AMT-007 determination	eq. 1, 8–10	— (system)	Tool documentation	G-RESET
Fossil fuel for ignition / start-up of the genset	Metered fuel	eq. 21–22	Fuel line / tank	Fuel-purchase records	G-RESET
Parasitic electricity of the gas-collection / destruction system	Sub-meter	(Accompanying)	Collection plant	Sub-meter log	A6.4-AMM-001
Upstream feedstock (where no Accompanying Methodology is applied)	Per feedstock	eq. (activity/leakage)	—	Documented	G-RESET (as activity/leakage)

A 5.3.2| **Shared parameters.** Where a parameter is needed by both methodologies (e.g., net electricity exported), it is metered once and used consistently, but the resulting emission reduction is attributed to a single methodology per Table 5.2. Biogenic CO_2 from combustion is treated under the Accompanying

Methodology and the prevailing IPCC guidance, and is not quantified under G-RESET.

A 5.3.3| **No Accompanying Methodology**: Where the developer does not apply an Accompanying Methodology, the non-power outcomes are not credited, and all upstream emissions (feedstock cultivation, processing, transport, and fugitive methane) shall be quantified under G-RESET as activity emissions or leakage (Sections 5.1.1, 8, 9).

A 5.4| CDM methodologies Transition mapping

A 5.4.1| Transitioning activities migrate under the applicable GS4GG transition procedure, at renewal or voluntarily beforehand(Sections 11.5, 17). The following mapping is indicative; the A6.4 tools (AMT-007 / 006 / 002, as modified by the applicable PAA addenda) replace the corresponding CDM tools, and G-RESET's additionality, embodied-emissions leakage, ambition DAF and monitoring-period storage floor apply.

Table 5.3. Indicative transition mapping of legacy methodologies

Legacy methodology	Scope	Maps to G-RESET module(s)	Migration notes
CDM ACM0002	Grid-connected renewable electricity generation (large scale)	Module GG (greenfield); Module BO (retrofit/capacity additions, via the Declining Baseline); Module ST (integrated storage)	A6.4 tools replace CDM TOOL07/05/02; G-RESET additionality, embodied leakage, ambition DAF and storage floor apply.
CDM AM0123	Grid-connected renewable electricity generation, including supply to captive and third-party consumers	Module GG (grid export) and Module CG (captive/contracted supply); + Module ST if a BESS is integrated	Broader than captive-only. Grid-exported output → Module GG; captive/contracted output → Module CG under the MIN(captive, grid) rule (Section7); AM0123's extension to group-captive / corporate-PPA / third-party supply is carried by the Module CG captive definition.
AM_REV_0267		Module CG (captive/contracted supply; third-party/shareholding via AM_REV_0267); Module GG only for surplus exported beyond the captive	Captive supply → Module CG under the MIN(captive, grid) rule (Section7); grid-wheeling is the delivery mechanism, not grid-displacement crediting.

		load; + Module ST if a BESS is integrated	
CDM AM0103	Renewable energy power generation in isolated grids V4.0	Excluded	GS4GG energy-access methodology) | Isolated-grid / off-grid generation is outside scope (Section 3.2), consistent with the AMS-I.F treatment. A captive consumer on a grid-connected system remains within Module CG
CDM AMS-I.D	Grid-connected renewable electricity generation (small scale)	Module GG; Module BO	Small-scale activities above the micro-scale threshold (10,000 tCO_2e/yr) perform the full additionality assessment; only micro-scale activities may use the positive-list route (Section6.2).
CDM AMS-I.F	Renewable electricity generation for captive use / mini-grids	Module CG	Captive supply → Module CG. Suppressed-demand, isolated-mini-grid and un-electrified-population configurations are ineligible under this methodology (Section 3.2) and migrate instead to the GS4GG energy-access methodology.
CDM AMS-I.A / I.C / I.L	User/household electricity; thermal or mechanical applications	Excluded / Accompanying	Outside the grid-connected/captive scope, or handled via an Accompanying Methodology; not credited under G-RESET on a suppressed-demand basis.
Earlier GS4GG versions	Per the modules deployed	Per the modules deployed	Migrated under the applicable GS4GG transition/conversion procedure; reassessed at the next renewal.

A 5.5| Worked example - landfill gas to power

A 5.5.1| LFG-to-power activity paired with A6.4-AMM-001. A landfill captures methane and combusts it in a 5 MW genset exporting to the grid. Two methodologies apply.

a. Under A6.4-AMM-001: the methane captured and destroyed is credited (CH_4 → CO_2), and the biogenic CO_2 of combustion is accounted there.
b. Under G-RESET (Module GG): the net electricity exported (say 35,000 MWh/yr) displaces grid generation at the combined margin (say 0.55 tCO2/MWh) → BE_{GG} = 35,000 x 0.55 = 19,250 tCO_2e, adjusted by the DAF; fossil start-up fuel is deducted (eq 21and 22); embodied emissions of the genset/balance-of-plant are deducted as leakage.
c. Boundary check: methane destruction and biogenic CO_2 are NOT counted under G-RESET; the electricity displacement is NOT counted under A6.4-AMM-001. No source is double-counted.

A 5.6| References / tools

A6.4-AMM-001 (Flaring or use of landfill gas).

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

A6.4-AMT-006 (technical lifetime);

A6.4-AMT-002 (investment analysis).

IPCC (2006), Guidelines for National Greenhouse Gas Inventories (treatment of biogenic CO_2).

CDM ACM0002; AM0123; AMS-I.D; AMS-I.F; AMS-I.A / I.C / I.L (legacy methodologies referenced for transition- latest versions).

Annex -6|Additionality Support, Eligibility Screens, and the Micro-scale Positive List

A 6.1| Purpose

A 6.1.1| This Annex provides the supporting analysis for the additionality demonstration of Section 6: the common-practice framework (section 6.6), the lock-in risk screen (section 6.4), the geothermal emission-intensity eligibility screen, indicative investment benchmarks (section 6.5), and the micro-scale Positive List (section 6.2). The screens in A.6.3–A.6.4 provide the evidentiary basis for the methodology's technology exclusions.

A 6.2| Common-practice (MT400-06)

A 6.2.1| The common-practice analysis of Section 6.6 applies MT400-06 with the deviations stated there. This section records the reasons.

A 6.2.2| **Single threshold.** A single F_{max} of 10%, the tool's stock-based value for Early Adopter technologies outside LDCs and SIDS, applies to every technology, and technology maturity is not classified. The value is below the 16% the tool gives Early Majority technologies, and it removes the classification judgement from the activity developer. For a technology the tool would classify as Innovator/Nascent (2.5%), the single threshold is higher. Such technologies rarely reach either value without carbon revenue, and the tool's deemed additionality for that category, which would otherwise exempt small activities from the Investment Analysis, does not apply. The tool's LDC and SIDS values are not used; the exemption of Section 6.6.1(h) addresses the small-system case instead.

A 6.2.3| **Exemption for small activities in LDCs and SIDS.** In a small electricity system, one existing installation can place a technology above the threshold although its deployment remains limited. The exemption removes the common-practice analysis, and only that analysis, for activities up to 5 MW in LDCs and SIDS; the Investment Analysis continues to test financial additionality. Larger activities in small systems are tested against the threshold.

A 6.2.4| **Common total and supply configuration.** Every module is measured against the total installed capacity of the electricity system, so the ratio remains meaningful where a technology is new to a market. Against a narrower total, storage and VPP shares approach 100% as soon as one uncredited installation exists. Captive and aggregated supply form their own configuration because their adoption follows consumer-side economics distinct from bulk supply; where data do not separate the configuration, the comparison falls back to the wider class, which gives the higher share. Against the whole system, storage and VPP shares will remain low for some years, and the Investment Analysis is the operative test for those modules.

A 6.2.5| **Indicator and basis.** Installed capacity is the indicator because it measures deployment directly and identifies common practice earlier than generation

share. A stock basis applies to every technology; market timing for mature technologies is addressed in the Investment Analysis through recent competitive prices (Section 6.5.1(b)). Installed capacity shall be evidenced from official statistics or authoritative datasets (IRENA Renewable Capacity Statistics; IEA).

A 6.3| Lock-in risk method (combustion technologies and reservoir hydropower)

A 6.3.1| The fossil-lock-in screen (Section6.4) tests whether an activity could entrench GHG-emitting or carbon-intensive infrastructure inconsistent with the Paris long-term goals. It applies to the power-generation component of biomass, biogas and landfill-gas activities, and to reservoir hydropower, comparing life-cycle emission intensity against the host Party's LT-LEDS using the GS4GG Methodology Tool: Analysis of Lock-in Risk (MT400-XX).

A 6.3.2| **Why the screen is confined to combustion and reservoir hydropower and how this supports the exclusions.** A technology can create fossil lock-in only if it is interchangeable with, or co-fireable alongside, fossil generation, or otherwise entrenches fossil infrastructure. On that test:

a.| **Solar, wind, run-of-river hydropower, marine and storage** are not fossil-substitutable and cannot be co-fired; they create no fossil lock-in. A quantitative lock-in test is therefore not required (compliance with the applicability and safeguard conditions of Section 3.2 demonstrates conformance). This is the safe-harbour treatment of technology classes that logically cannot create fossil lock-in (precedent: JUST — Coal Decommissioning).

b.| **Geothermal** likewise creates no *fossil* lock-in (it is not fossil-substitutable or co-fireable); it is removed from the fossil-lock-in screen. Its emissions are an emission-intensity question handled by the separate screen at A.6.4 and quantified as activity emissions (Section 8, eq. 25).

c.| **Combustion technologies (biomass, biogas, LFG)** can be co-fired with fossil fuel and their life-cycle intensity varies widely; they retain the lock-in screen, which requires sustainable feedstock (no high-carbon-stock land; Section 3.2) and confirms the component's intensity is consistent with the host decarbonisation pathway.

d.| **Reservoir hydropower** retains the screen: reservoir emissions make its life-cycle intensity variable, and a reservoir is a long-lived asset (Section 3.2.4(a)).

A 6.3.3| **Support for the negative list.** The same reasoning underpins the methodology's exclusions (Section 3.2): continuous fossil co-firing is prohibited (it is the paradigm fossil-lock-in case — entrenching a fossil-fuel supply chain behind a nominally renewable asset); and waste-heat recovery is excluded and directed to a dedicated methodology, because crediting

WHR from a fossil host process risks rewarding, and thereby entrenching, that process.

A 6.4| Geothermal emission-intensity eligibility screen

A 6.4.1| Geothermal creates no fossil lock-in (A.6.3), but its direct emission intensity varies by more than three orders of magnitude with the geology of the resource, so a blanket eligibility would be unsafe — a high-CO_2 field can emit more than the grid it displaces. This screen therefore supports the exclusion of high-emission geothermal fields, independent of the fossil-lock-in question.

a.| Binary and enhanced-geothermal (EGS) plants, and plant-cycle (manufacturing) emissions: ≈ 2–20 gCO_2e/kWh (Sullivan et al., 2013; Fridriksson et al., 2016).

b.| Global-average flash/dry-steam fields: ≈ 121 gCO_2/kWh (Bertani & Thain, 2002; Fridriksson et al., 2016).

c.| Carbonate-hosted and high-CO_2 fields: ≈ 500–1,300 gCO_2/kWh (the ESMAP ex-ante value for carbonate bedrock is 790 gCO_2e/kWh; some Turkish fields reported 1,000–1,300 g/kWh at commissioning — Akin et al., 2020) — which can exceed the grid being displaced.

A 6.4.2| **Assessment.** The ex-ante emission factor shall be estimated following the ESMAP approach (Fridriksson et al., 2016) — the global average plus 5% for greenfield activities in unknown conditions, or the carbonate value where applicable — or from measured non-condensable-gas data where available (eq. 25). A field whose emission intensity exceeds the displaced grid factor is ineligible unless it implements verified abatement (e.g., CO_2 reinjection, credited via r_{reinj} in eq. 25); its emissions are in any case quantified as activity emissions (Section 8). This screen operates whether or not the fossil-lock-in screen applies.

A 6.5| Indicative investment benchmarks

A 6.5.1| To support (not replace) the A6.4-AMT-002 investment analysis (Section 6.5), the activity developer may reference recognised, current sectoral cost and performance datasets - principally IRENA's annual *Renewable Power Generation Costs* and the IEA - for levelised cost of electricity, capital cost, capacity factor and, for storage, energy-arbitrage and capacity-market revenue benchmarks, by technology and region. These are the evidence base for the mature-technology benchmark discipline (section 6.5): for utility-scale solar PV and onshore wind, the analysis shall be corroborated against recent auction/PPA prices and this cost data, and shall show that carbon revenue closes a documented viability gap rather than resting on assumption choices.

A 6.5.2| **Real-terms modelling.** Cash flows shall be modelled in real terms, with inflation applied consistently across all cash-flow lines and the discount rate stated on a consistent basis. The binding analysis remains the activity-

specific NPV/IRR comparison under A6.4-AMT-002, with the sensitivity analysis the tool prescribes.

A 6.6| Micro-scale Positive List

A 6.6.1| **Availability.** A micro-scale activity (≤ 10,000 tCO_2e/yr) that matches a listed type is deemed financially additional and is not required to conduct the Investment Analysis (Section 6.5) or the Common Practice Analysis (Section 6.6). It shall nonetheless satisfy regulatory surplus (Section 6.3) and, for combustion technologies, the fossil-lock-in screen (Section 6.4). Small- and large-scale activities may not use this route (Section 6.2). For a VPP (Module VPP), eligibility is assessed at the aggregator/platform level. A listed activity whose public funding, expressed in grant equivalents, exceeds its expected carbon revenue may use the list only where it demonstrates that the public funding would not have filled its funding gap (A6.4-AMT-002, paragraph 30(i))

A 6.6.2| Inclusion criteria (three-part test). A micro-scale activity type is listed only where all three are demonstrated on the evidence in this Annex. The three-part test governs the listing and periodic review of activity types by Gold Standard; an individual activity demonstrates only that it matches a listed type and satisfies the conditions stated in the listing:

a.| Documented barriers — verifiable investment, technological, institutional or informational barriers that impede the activity type in the relevant contexts absent carbon revenue.

b.| Low penetration — observed market penetration in the relevant contexts materially below the common-practice threshold of Section 6.6.1(g) (evidenced from IRENA/IEA).

c.| Viability gap — cost/viability analysis showing the type is not financially attractive without carbon revenue (negative or sub-benchmark returns on representative parameters).

Table 6.2. Micro-scale Positive List

#	Micro-scale activity type (≤ 10,000 tCO_2e/yr)	Barriers	Penetration	Viability	Conditions
PL-1	Distributed rooftop / C&I solar PV serving a captive or contracted low-income load (identified by objective indicators,	High upfront cost; limited access to affordable finance; informational and split-incentive barriers	Low in the target contexts	Negative/sub-benchmark without carbon revenue	Module GG/CG

	e.g., national poverty lines / wealth quintiles)				
PL-2	Behind-the-meter storage for temporal carbon shifting in a grid with a high-emitting evening peak	Nascent technology; capital cost; absence of an established arbitrage-revenue market	Low (grid-scale/BTM storage nascent in most markets)	Sub-benchmark without carbon revenue	Module ST; Tiered Temporal Accounting (Annex 2); monitoring-period floor
PL-3	VPP aggregating residential DERs (rooftop solar and/or home batteries) at the platform level	Aggregation-platform and customer-acquisition costs; regulatory novelty; small per-node economics	Low (aggregated flexibility nascent)	Platform-level returns sub-benchmark without carbon revenue	Module VPP; assessed at the Digital Aggregation Perimeter; Aggregation Reconciliation Waiver (Section14, Annex 4)
PL-4	Micro-scale biogas / biomass-residue to power (power-generation component)	Feedstock-logistics and capital-cost barriers; limited access to finance	Low	Sub-benchmark without carbon revenue	Module GG/BO; subject to the fossil-lock-in screen (Section6.4) and sustainable-feedstock condition (Section 3.2)

A 6.6.3| **Evidentiary basis (representative).** The qualifying basis of each listed type rests on representative evidence for the contexts in which it is listed. For PL-1 (distributed solar serving low-income loads), the affordability and finance-access barriers and the low penetration in the target contexts are documented in the ESMAP/GOGLA Off-Grid Solar Market Trends Report 2024; for example, only about a fifth of unelectrified households can afford a Tier-1 solar kit even on pay-as-you-go. PL-2 to PL-4 rest on the documented nascency and sub-benchmark economics of grid-scale and behind-the-meter storage, aggregated flexibility and micro-scale bioenergy in most markets (IRENA and IEA cost and capacity data)..

A 6.7| References

Akin, S., & Orucu, Y. (n.d.). Characterizing the declining CO_2 emissions from Turkish geothermal power plants. Geothermal Resources Council / Stanford Geothermal Workshop proceedings.

Bertani, R., & Thain, I. (2002). Geothermal power generating plant CO_2 emission survey. IGA News, 49, 1-3.

Energy Sector Management Assistance Program, & GOGLA. (2024). Off-grid solar market trends report 2024. World Bank.

Fridriksson, T., Mateos, A., Audinet, P., & Orucu, Y. (2016). Greenhouse gases from geothermal power production (ESMAP Technical Report 09/16). World Bank, Washington, DC. https://openknowledge.worldbank.org/handle/10986/24691

International Energy Agency. (n.d.). *World energy outlook / electricity market reports.* IEA.

International Renewable Energy Agency. (n.d.). Renewable power generation costs. IRENA, Abu Dhabi.

International Renewable Energy Agency. (n.d.). Renewable capacity statistics. IRENA, Abu Dhabi.

Sullivan, J. L., Clark, C. E., Han, J., Harto, C., & Wang, M. (2013). Cumulative energy, emissions, and water consumption for geothermal electric power production. Journal of Renewable and Sustainable Energy, 5(2), 023127. https://doi.org/10.1063/1.4798315

Annex -7|Worked Examples

A 7.1| Purpose

A 7.1.1| Worked examples illustrating the application of Sections 7 to 10 for each module and for an Integrated Solution are provided in the supporting calculation tool published with this methodology. The tool is a supporting file; where it and this methodology differ, this methodology prevails.

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