METHODOLOGY

RECOVERY AND RECYCLING OF MATERIALS FROM SOLID WASTES

SDG 13

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SUMMARY

This methodology is applicable to projects that implement activities for the recovery and recycling of metals, alloys, and minerals. These activities lead to the reintroduction of valuable materials from end-of-life waste back into the economy, substituting the use and production of virgin materials, thereby leading to reduced resource and energy consumption and avoidance of associated greenhouse gas emissions.

The methodology expands upon two existing CDM methodologies "AMS-III.AJ- Recovery and recycling of materials from solid waste" and "AMS-III.BA- Recovery and recycling of materials from e-waste". It broadens the scope of the methodology by including a wider range of materials as well as the extends applicability to Annex 1 countries.

ACKNOWLEDGEMENT

This methodology was developed by South Pole.

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1| Introduction

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

Table 1. Key information

Typical mitigation activity (project) type	The following materials which are recovered from municipal solid wastes (MSW) and recycled into intermediate or finished products are covered in the methodology: • Metals • Alloys • Minerals
Activity requirement	NA, GS4GG Principles and Requirement applies
Mitigation activity (project) type	Energy efficiency: Reintroduction of valuable materials from end-of-life waste back into the economy, substituting the use and production of virgin materials, thereby leading to reduced resource and energy consumption.
Applicable GS4GG products	☒ GSVERs ☒ Certified impact statement
Geographical applicability	Global
Applicable activity (project) scale	☒ Micro scale ☒ Small scale ☒ Large scale A proposed activity can claim emission reductions less than or equal to: - 10,000 tCO_2 eq per year for Micro scale activity - 60,000 tCO_2 eq per year for small-scale activity - No emission per year cap for large-scale activity
Mitigation type	☒ Emission reduction ☐ Emission removal
Project activity start date	The earliest date on which the project developer has committed to expenditures related to the implementation of the proposed mitigation activity.
Crediting period start date	The start date of Crediting Period is the date of start of operation or a maximum of two years prior to the date of Project Design Certification, whichever occurs later.
Crediting period length	Fifteen years (maximum); the mitigation activity follows five-year renewal cycle per latest version of GS4GG requirements for renewal of crediting period.

	If any legal mandate comes into force during the crediting period, the mitigation activity can be credited only until the date the legal requirements take effect.

2| Definition

2.1.1 | For the purpose of this methodology, the following definitions apply:

Table 2. Terms and definitions

Term	Definition
Customer	The direct buyer of the recyclate or product fabricated within the project boundary, thereby taking it outside of project scope where further processing or distribution takes place
Cradle to gate	A partial product life cycle from resource extraction (cradle) to the factory gate (before it is transported to the customer)
End-of-life waste	A post-consumer waste of products, which the owner has discarded, intends to discard or is required to discard and which is typically not reintroduced into any new product cycle or is not reusable in its current form
Incinerator bottom ash	A form of ash produced in waste incineration facilities, such as waste-to-energy plants
Life cycle assessment	An analysis technique to assess environmental impacts associated with all the stages of a product's life, which is from raw material extraction through materials processing, manufacture, distribution, and use
Materials	The various resources eligible in this methodology, ranging from minerals, metals, and alloys
Raw materials	Materials used in a production process, which have a low level of completion compared to the final product. Virgin materials and recyclates both fall under raw materials
Recovery	The action or process of regaining possession and control of a certain type of waste and the extraction of valuable and usable material from it.
Recyclate	The valuable raw material obtained after waste has undergone a recovery process. In this methodology, these are recovered metals, alloys, and minerals
Recycling	The action or process of converting a recyclate into a reusable form or product
Virgin material	Materials that have not yet gone through a cycle of use and recovery

Virgin material production	The process of extracting and refining materials from their natural sources

3| Scope, Applicability, and entry into force

3.1 | Scope

3.1.1 | This methodology is globally applicable and comprises activities for the recovery only, or for the recovery and recycling of metals, alloys, and minerals (hereafter referred to as "materials") in solid waste streams.

3.1.2 | The activity leads to the reintroduction of valuable materials from end-of-life (EOL) waste (hereafter referred to as "waste") back into the economy, substituting the use and production of virgin materials, thereby leading to reduced energy consumption and avoidance of associated greenhouse gas (GHG) emissions.

3.1.3 | The activity comprises the increase of the recovery activity only, or of the recovery and recycling activity above the baseline activity and is referred to as "project activity" unless mentioned otherwise.

2.1.4 | The methodology is applicable to all the scales.

3.2 | Applicability

3.2.1 | The waste streams that are eligible in this methodology shall fulfil the applicability conditions and means of validation or verification detailed in table **3** below:

Table 3. Applicability conditions that apply to the waste stream/s and the respective requirements for validation/verification.

Applicability criteria	Means of validation/verification
a. Eligible waste streams include municipal solid waste, industrial waste, incinerator bottom ash, e-waste and/or any other solid waste stream, provided that they do not contain significant amounts of mercury[1], infectious, or radioactive elements.	The project proponent shall provide either: • Third-party approved analytics reports of the waste streams, proving that no such harmful elements are present in the waste stream; or • Proof that the recovery facility includes infrastructure capable of filtering out such elements in the recyclate and have third-party

[1] To ensure compliance to the Minamata Convention.

	verified health and safety measures for waste handling in place.
b. Solid waste streams are collected or diverted from one of the following: • environment; • landfill; • open dumping/burning; • waste incineration plants; • households and/or commercial entities; • other waste management streams that do not, per common practice, allow for recovery and recycling in the waste stream.	The project proponent must provide either: • Purchase or delivery receipts; or • Other documentation that can proof the collection of the waste.
c. The diverted waste should be at its EoL without the project activity. This means that the collection of scraps generated during an intermediate or final production process which would have been reintroduced into a product cycle even without the project activity is excluded.	Covered by proof provided for under criteria b. Moreover, the project developer shall be able to demonstrate what would have happened to the waste in the baseline scenario.
d. Transboundary movement of the waste stream may occur only if it is aligned with the Basel Convention[2], regional law, and national law.	1. Reference to regulation; 2. Waste handling and tracking control compliance documents (green control procedure for Annex IX wastes and yellow control procedure for Annex II and VIII); and 3. If applicable, contracts or government authorisations between the localities or states.

3.2.2 | The project activity applicability criteria and the respective means of verification are detailed in table 4 below:

[2] The Basel Convention prohibits the export of hazardous wastes to countries with less-advanced storage and disposal facilities unless the importing state has detailed information on the waste shipment and gives prior written consent.

Table 4. Applicability conditions that apply to the recovery facility and recyclates and the respective requirements for validation/verification.

Applicability criteria	Means of validation/verification
a. Each type of recyclate must be sold to a downstream chain of intermediary retailers, recycling or manufacturing facilities, guaranteeing the recycling/utilisation of the materials and substitution for virgin materials downstream.	Invoices from sales of recyclates.
b. Each type of waste leaving the project activity facility is disposed of according to the national and/or regional waste handling regulations. Transboundary movement of the waste stream may occur, only if it is aligned with the Basel Convention[3], regional law, and national law.	1. Documentation of end waste destination e.g. contracts, delivery receipts; 2. Waste handling and safety protocol; and 3. Tracking control documents or other reference to compliance with regulation. If no regulation exists in the country, the EU Waste Framework Directive or similar policy shall be referred to.
c. Transboundary movement of the recyclate is allowed provided that the downstream destination can be tracked and the recyclate is either: • not classified as “waste” according to legislation; or • classified as waste but falls under the green list of the Basel Convention, OECD guidelines, or comparable regional legislation. • classified as waste but falls under the yellow list of the Basler Convention, requiring special government authorisation.	1. Documentation of downstream destinations e.g. invoices; 2. If classified as waste: the approved tracking control documents (green control procedure or yellow control procedure depending on the material and quality/grade); including the six-digit code assigned to the material; and 3. Other authorisation documentation.

[3] The Basel Convention prohibits the export of hazardous wastes to countries with less-advanced storage and disposal facilities unless the importing state has detailed information on the waste shipment and gives prior written consent.

d. The recyclates can be utilised as raw materials in the production of the same downstream product as the virgin materials. Moreover, the necessary processing steps and quality of the recyclates are comparable to those of the substituted virgin materials, or an appropriate substitution factor can be determined.	1. Either: • Quality test results or credible documentation proving that the properties and quality of the recyclates conform with relevant norms and are comparable to virgin materials substituted; or • Statement from the customer, confirming the use of the recyclates in a new product cycle and the substitution ratio with virgin materials without impact on end-product quality.

3.3 | Safeguards

3.3.1 | The project shall conform to the latest version of the Gold Standard for the Global Goals Safeguarding Principles & Requirements.[4] It shall identify potential risks according to the principles assessment procedure and adapt a mitigation strategy where necessary.

3.3.2 | The project shall comply with all national, sub-national or local regulations relevant to the project activity.

3.3.3 | To avoid double counting of GHG benefits or double claiming in another voluntary or regulated carbon programme (e.g. due to the formal waste sector, due to downstream recycling/processing/manufacturing facilities), the project developer must clearly communicate all GHG reduction claims to relevant stakeholders. Documented written communication of GHG reduction claims shall be submitted.

3.3.4 | It is the project developer's responsibility to ensure that all data and monitoring requirements are met through a well-defined monitoring plan and data storage system.

3.4 | Entry into force

3.4.1 | The date on which this methodology enters into force on its publication date.

4| Baseline Methodology

4.1 | Project Boundary

4.1.1 | The project boundary includes the following processes and GHG emissions:

[4] https://globalgoals.goldstandard.org/103-par-safeguarding-principles-requirements

a. Baseline scenario: virgin material production processes from cradle to gate (this includes GHG emissions from the entire production process from resource extraction to the factory gate, *i.e.* before it is transported to the customer) and energy consumption from existing mandatory or status quo material recovery and recycling;

b. Project scenario: solid waste collection to materials recovery processes (given that proof of recycling downstream of the project boundary is provided), or materials recovery and recycling processes at the project facility. Transportation to the direct downstream customers is within the project boundary unless considered *de minimis*. If applicable, emissions from the production of chemicals are accounted for under leakage emissions.

4.1.2 | The project boundary, including the equivalent baseline scenario, is illustrated in figure 1 below. The project boundary is project-level specific, and may include the recovery process only, or the recovery and various recycling steps in between (outlined with dotted lines in the figure 1), until the recyclates serve as equivalent raw materials like the virgin materials in products downstream. Specific recycling stages included in the project boundary shall be clearly defined at project level.

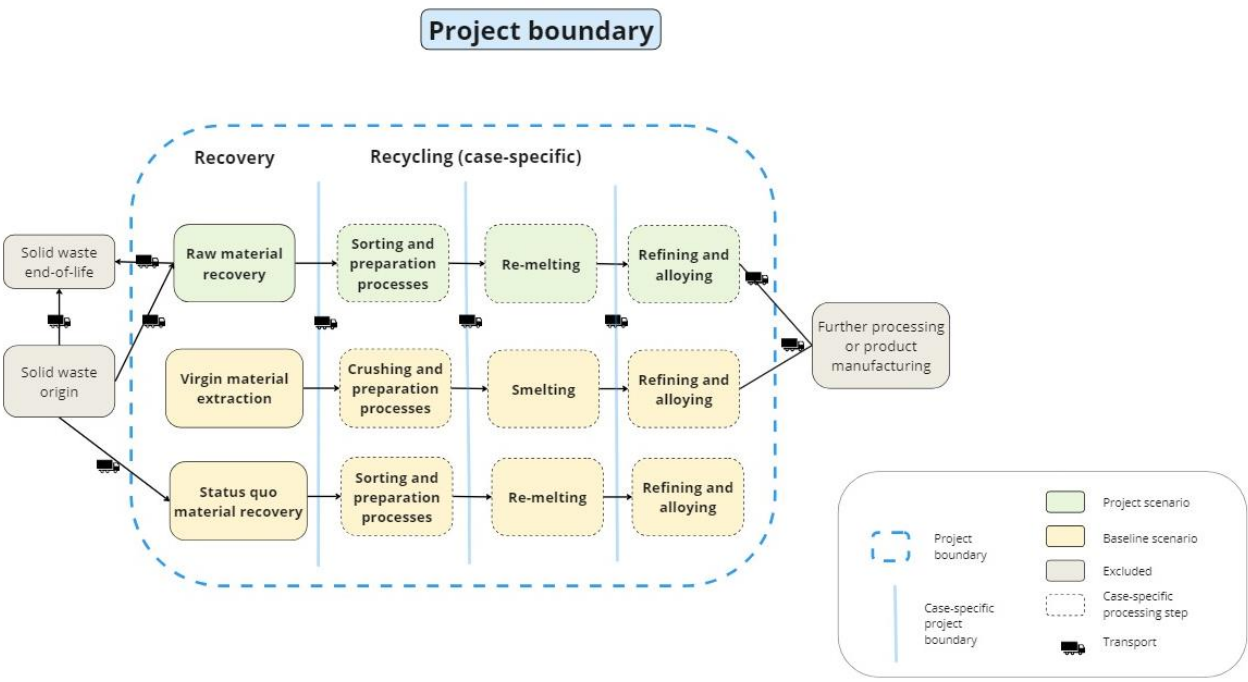

Figure 1. Project boundary. Specific recycling stages included in the project boundary are case-specific and shall be clearly defined at project level.

4.1.3 | The project activity includes the recovery only or recovery and recycling of solid waste streams through one or more of the following:

a. Installation of a new facility (greenfield project);

b. Capacity addition to an existing facility (brownfield project) retrofit or modification of an existing facility (e.g. through technology improvement, installation of new equipment, replacement of old equipment);

c. Incentivising and/or facilitating an increase in recovery (respectively in recovery and recycling) above the baseline recovery (respectively in recovery and recycling) activity (e.g. improvement of waste collection or extraction systems).

4.2 | Emissions sources included in the project boundary

4.2.1 | Project activity emissions include emissions from energy use during collection, recovery and recycling processes. Emission reductions can be claimed for the difference in GHG emissions for the production of materials from virgin inputs, including status quo recovery rates and emissions, versus the emissions from recovery through the project and production using recyclates.

Table 5. Emissions sources included in or excluded from the project boundary.

Scenario	Source	Gas	Included	Justification/ Explanation
Baseline scenario	Emissions from the production of virgin materials (from cradle to gate)	CO_2	Yes	Major source of emissions across the mining and production process, including cradle to gate transportation
		CH_4	Yes	Some processes may involve the release of CH_4 (e.g. iron and steel, mineral mining). This should be accounted for in the product EFs.
		N_2O	Yes	Some processes may involve the release of N_2O (e.g. iron and steel production). This should be accounted for in the product EFs.
	Emissions from the transportation of virgin materials to direct downstream customers	CO_2	No	Excluded in order to be conservative
		CH_4	No	Not applicable
		N_2O	No	Not applicable
	Emissions from energy usage in baseline recovery and recycling processes	CO_2	Yes	Yes
		CH_4	No	Not applicable
		N_2O	No	Not applicable
Project scenario	Emissions from the transportation of the waste stream from	CO_2	Yes	Transportation emissions occur where the waste stream origin and the recovery site are not at

	the source to the recovery site and remaining waste to the landfill			the same location.
		CH_4	No	Not applicable
		N_2O	No	Not applicable
	Emissions from the recovery of materials	CO_2	Yes	Electrical energy and/or fuel energy may be required at the recovery facility
		CH_4	No	Not applicable
		N_2O	No	Not applicable
	Emissions from the recycling of materials (if recycling is included in the project activity)	CO_2	Yes	If recycling occurs within the project boundary, additional processing steps may cause emissions
		CH_4	No	Not applicable
		N_2O	No	Not applicable
	Emissions from the transportation of recyclates to direct downstream customers	CO_2	Yes	Emissions from transportation to customer are included unless proven *de minimis*
		CH_4	No	Not applicable
		N_2O	No	Not applicable
Leakage	Emissions from the production of chemicals used during recovery and/or recycling	CO_2	Yes	Some recovery and recycling processes may require the application of chemicals which are included unless proven *de minimis*
		CH_4	Yes	Some chemicals production processes may involve the release of CH_4. This should be accounted for in the product EFs.
		N_2O	Yes	Some chemicals production processes may involve the release of N_2O. This should be accounted for in the product EFs.
	Emissions from recycling processes, downstream of the project activity	CO_2	Yes	Emissions occur where additional processing steps are necessary for recycling of material
		CH_4	No	Not applicable

	N_2O	No	Not applicable

4.2.2 | Transportation emissions in the project scenario shall be accounted for as detailed in section 4.7.

4.3 | Demonstration of additionality

4.3.1 | The project proponent shall demonstrate additionality by conforming to following additionality requirements and the latest active version of the GS methodology standard: requirements for additionality demonstration. **Step 1: Identification of alternatives to the project activity consistent with mandatory laws and regulations.**

4.3.2 | **Regulatory Surplus Analysis:** If the proposed project activity is the only alternative amongst the ones considered by the project participants that is in compliance with mandatory regulations, then the proposed project activity is not additional. The project developer shall also demonstrate that the mitigation activity type is not excluded or declared ineligible for carbon crediting issuance by the host country. Where the national and/or regional law or regulations mandate recovery and recycling of a material up to a certain quantity/percentage, only the recovery and recycling activity above the mandatory requirement is eligible for crediting. Project developer shall demonstrate that the emission reductions caused by the mitigation activity would not occur due to any enforced legal requirements. For high-income countries, all legal requirements shall be deemed to be enforced. For other countries, legal requirements shall only be deemed to be unenforced if non-enforcement is widespread (i.e. more than 50%) and documented through credible, authoritative and up-to-date evidence of non-enforcement that is relevant and applicable to the mitigation activity.

4.3.3 | The analysis shall verify that legal requirements do not:

a. Directly mandate the implementation of the mitigation activity (e.g., a regulation requires material recovery and/or recycling);

b. Indirectly mandate the implementation of the mitigation activity by preventing alternative scenarios, including the baseline scenario (e.g., solid waste disposal standards that can only be met by recovery and recycling of materials from waste);

c. Lead to the same amount of emission reductions without the mitigation activity due to laws or regulations requiring specific quantitative targets (e.g., an emissions trading system that caps the emission sources reduced by the mitigation activity).

4.3.4 | The analysis shall be based on credible, and up-to-date evidence and be thoroughly justified.

4.3.5 | The regulatory surplus shall be demonstrated at a specific mitigation activity level at each renewal of the design certification.

4.3.6 | **Lock-in risk analysis** :Project developer shall demonstrate that the recovery and recycling of specified materials from solid waste align with the host country's long-term low-emission development strategy (if submitted) or the Paris Agreement's long-term goal.

4.3.7 | Under this methodology it is assumed that the mitigation activity do not lock-in current emission levels or continue emissions-intensive practices, hence no further analysis is required.

4.3.8 | **Investment analysis:** The project developer shall

a. demonstrate that the project faces capital or investment return constraints which can be overcome by the additional revenues associated with the sale of carbon credits.

b. use relevant financial indicators, such as the internal rate of return (IRR) or the net present value (NPV) are calculated and compared to benchmark values (such as expected returns from venture capital or private equity investments) for the corresponding project type.

c. present the investment analysis in a transparent manner and provide all the relevant assumptions. A sensitivity analysis must be included.

4.3.9 | **Barrier analysis:** Optional if **Investment analysis** is fulfilled. The project developer shall

a. demonstrate barriers that prevent the implementation of the project activity without the revenue from sales of carbon credits. Such barriers include institutional barriers, informational barriers, technological barriers and additional economic barriers, and

b. demonstrate that the identified barriers would not prevent the implementation of at least one of the alternative scenarios.

4.3.10 |Project developer shall confirm that no other programs or incentives, such as subsidies, would independently incentivise the mitigation activity and would provide evidence to prove that the carbon credit revenue is crucial in overcoming the identified barriers.

4.3.11 |**Common practice:** The project proponent must demonstrate that the project activity is not common practice in the project region (host country), by analysing other recovery and recycling activities similar to the proposed project activity and explaining essential distinctions between them. It must also be demonstrated that the project is exceeding common practice for any recovery/recycling levels already present within the specific industry in which the project activity takes place.

4.4 | Baseline scenario determination

4.4.1 | The baseline scenario corresponds to emissions on two levels: 1) the production of virgin materials and 2) emissions from the mandatory or status quo recovery and recycling activities in the project region.

4.4.2 | The baseline emissions on level 1 are based on the avoided emissions from processes that may include the following:

a. Virgin metal production: includes the mining, extraction, smelting, and processing of virgin metal ores and virgin materials to manufacture metals, metal oxides, or alloys. These include but are not limited to aluminium, stainless steel, copper, gold, silver, lead, iron, zinc, brass, and iron;

b. Virgin mineral production: includes quarrying, crushing, and where appropriate further production stages. Virgin minerals are for example used in the clinker production process (such as calcium carbonate and marl), concrete production process (such as gravel), used as virgin meal corrective substances in the clinker production process (such as iron ore).

4.4.3 | Recyclates that may be recovered in the project scenario and the corresponding substituted virgin materials (used in the baseline scenario) must clearly be defined at the project level and proven to be at equivalent stages in the value chain or otherwise a substitution factor must be applied. To ensure comparability between recyclates and virgin materials, project proponents must have the capability to provide the following information: 1) composition, including quality; 2) equivalence in production stages between recyclate and virgin material, noting any additional steps that recyclates have to go through and 3) corresponding material or product emission factors from credible sources.

4.4.4 | The baseline emissions on level 2 account for emissions resulting from *status quo* recovery and recycling processes from the specific waste stream, if applicable. The baseline recovery and recycling activity is determined as detailed starting in subsection 4.6.4.

4.5 | Selection and justification of the baseline scenario

4.5.1 | The baseline scenario can include emissions from the entire virgin material production process, from cradle to gate, provided that the boundaries are well documented at the project level.

4.5.2 | This methodology only allows for recovery and recycling activities which are not common practice and above levels mandated by law.

4.6 | Baseline Emissions

4.6.1 | Mitigation activity shall demonstrate the baseline for emission reduction activities as being **below "business-as-usual" (BAU)** levels. It shall calculate the difference between the estimated baseline emissions and estimated BAU emissions as an annual and total amount for the crediting period.

4.6.2 | Total BAU emissions in year y are calculated as the sum of emissions associated with the production of virgin materials substituted by the project activity and status-quo recovery and recycling activity from the waste stream as follows:

$$BAUE_y = \sum_{i=1}^{n} (QR_{i,y} - QB_{i,w}) \times EF_i \times SF_i + EQB_{i,w} \qquad \text{Eq. 1}$$

$$BE_y = BAUEy * BAFy$$

Where:

BE_y	=	Baseline emissions in year y (tCO_{2e})
$BAUE_y$	=	BAU emissions in year y (tCO_{2e})
BAF_y	=	Baseline Adjustment Factor (a discounting factor to send baseline emission below BAU), to be determined case to case basis depending on trend analysis carried out over the crediting period based on assumptions. In absence of credible assumptions to determine activity specific BAFy, a factor of 99% reducing by 1% each year may be used (i.e. 99% in Year 1, 98% in year 2, 97% in year 3…).
i	=	Index for the material type
w	=	Index for the given waste stream(s)
$QR_{i,y}$	=	Quantity of recyclate of material type i used in downstream manufacturing to substitute virgin material type i in year y (t)
$QB_{i,w}$	=	Baseline recovery and recycling quantity for material type i from waste stream w (t), see below for calculation
EF_i	=	Emission Factor for the production of virgin material type i (tCO_{2e} /t)
SF_i	=	Substitution factor of virgin material type i per quantity of recyclate
$EQB_{i,w}$	=	Emissions from baseline recovery and recycling activity of material type i from waste stream w (tCO_{2e})

4.6.3 | The substitution factor SF_i indicates the rate at which virgin material type i can be substituted with a corresponding recyclate, e.g. 1.2 tonnes of recyclate yield the same performance as 1 tonne of virgin material. The substitution factor shall be determined for the respective substitute based on fractions, quality, and/or purity demonstrated with laboratory analyses or other credible documentation.

4.6.4 | Emission factors (EFs) for the production of avoided/replaced virgin material i can be obtained as follows:

a. using EFs or EF sources used by the country/ies or region, where the project is located and if applicable, where recyclates are mainly exported to, in their national GHG inventories or other government reports or statistics. If EFs differ, the most conservative value must be used;

b. If data from (a) are not available, EFs from third party verified life cycle assessments and environmental footprint declarations, provided that they are representative of the project context in terms of comparability to the processing stage of the substituted material i and geographical origin;

c. If data from a and b are not available, benchmark values from other credible sources as described in section 4.11. may be used, provided that they fulfil the same conditions as in b and conservativeness is justified.

4.6.5 | The baseline recovery and recycling activity for material type i from given waste stream w (〖QB〗 _(i,w)) is determined as follows:

If

$AQ_{i,w} \geq MR_i$,

then

$QB_{i,w} = AQ_{i,w}$;

else

$QB_{i,w} = MR_{i,w}$.

Where:

i	=	Index for the material type
w	=	Index for the given waste stream(s)
$QB_{i,w}$	=	Baseline recovery and recycling activity for material type i (t) from the given waste stream w
$AQ_{i,w}$	=	Average quantity of recovery and recycling of material type i from the given waste stream w in the baseline scenario per year (t / t of waste stream w)
$MR_{i,w}$	=	Mandatory recovery and recycling quantity of material type i from the given waste stream w per year (t / t of waste stream w)

4.6.6 | Values for the mandatory recovery and recycling quantity of material type i from waste stream w ($MR_{i,w}$) are obtained as follows:

a. from regional and/or national legislation that demand the recovery and recycling of material type i from the project activity's waste stream. Recycling or actual downstream reuse must be part of the legislation;

b. $MR_{i,w}$ shall be considered zero where there is no mandatory recovery and recycling quota for the material type i for the specific waste stream in the region/country;

c. where given legislation covers mandatory recovery but cannot be used to estimate $MR_{i,w}$, for example due to lacking specification of material type or inclusion of recycling, AQ_i shall be used to estimate $QB_{i,w}$.

4.6.7 | Values for the average quantity of material recovery and recycling ($AQ_{i,w}$) are obtained as follows:

a. If a new facility is built (greenfield project), the average quantity of material type i recovery and recycling from the specific waste stream w in the country or region is to be used and determined using either:

i. Credible sources as defined in section 4.11;

ii. Through a project-specific approach, using data from facilities conducting comparable recovery and recycling of the waste stream w in the same country or region where the project facility will be built;

b. For a capacity addition activity or technology improvement to an existing facility (brownfield project) that results in increased recycling capacity[5], as well as an activity which facilitates an increase in collection and recovery of materials above the baseline recovery activity, one of the following options shall be used:

   i. The baseline recovery and recycling activity for material type i from the given waste stream w is equal to the average annual recycling rate of material type i over the three-year period prior to the start of the project activity.

      Or;

   ii. If the facility has been operational for less than three years until the start of project activity, determine both the average recovery and recycling rate of the operating period so far and the regional average recovery and recycling rate as for greenfield projects above (see point a). AQ_{iw} shall correspond to the larger of the two values.

4.6.8 | GHG emissions from baseline recovery and recycling activity of materials i from waste stream w ($EQB_{i,w}$)[6] are obtained through one of the following:

a. Credible sources as defined in section 4.11;

b. Through a project-specific approach, using data from facilities conducting comparable recovery and recycling of the waste stream w in the same country or region where the project facility will be built. If this option is used, EQB is to be calculated in the same manner as EQP in equation 3;

c. If quantitative data is limited but credible sources confirm that the baseline technology is more energy intensive or the project technology is less energy intensive, the conservative assumption can be made that the baseline energy usage from recovery and recycling is at least equivalent to that of the project scenario. Otherwise, $EQB_{i,w}$ is zero.

4.7 | Project emissions

4.7.1 | Project emissions are calculated through the equation below:

$$PE_y = EQP_y + \sum_{i=1}^{n} TW_{w,y} + \sum_{i=1}^{n} TR_{i,y} \quad \textit{Eq. 2}$$

Where:

PE_y = Project emissions in year y (tCO_{2e})

[5] Project activities that increase the total installed recycling capacity of an existing facility prior to or during the project crediting period compared to the baseline are considered capacity additions.

[6] Emissions from baseline recovery and recycling are included to account for potential differences in the quality of recovered materials as compared to the project scenario, which may result in more energy intensive processing steps in the baseline prior to recycling.

EQP_y	=	Total GHG emissions from project activity facility operations in year y (tCO_{2e})
$TW_{w,y}$	=	GHG emissions from the transport of waste of type w in year y (tCO_{2e})
$TR_{i,y}$	=	GHG missions from the transport of recyclates type i in year y (tCO_{2e}) (unless proven de minimis)

4.7.2 | To calculate transportation emissions (TW and TR), the project proponent may follow the GS Tool 2 "Project and leakage emissions from road transportation of freight"[7] to calculate emissions from road transport of recyclates and waste freight. The default EF for freight transportation can also be sourced from national or third party verified databases. In the case of rail transport, the same procedure can be adapted.

4.7.3 | Emissions associated with transportation of waste (TW) to the recovery facility and subsequent transportation of waste remains/end waste to the landfill must be accounted for. Emissions associated with the transportation of recyclates (TR) to the direct customer (recycling/processing/manufacturing facilities) downstream of the project activity can be considered *de minimis* and may be disregarded if proven to be less than 1% of the total emission reductions. This is considered a conservative approach as emissions from downstream transportation (past the virgin material production gate) are excluded in the baseline scenario.

4.7.4 | Total GHG emissions resulting from the energy use for the operation of the project facility/ies (EQP) for the recovery and recycling of all materials in the project activity are calculated following the equation below:

$$EQP_y = EC_y \times EF_{el} + \left(\sum_{f=1}^{m} FC_{f,y} \times NCV_{f,} \times EF_f \right) \quad \textit{Eq. 3}$$

Where:

EQP_y	=	Total GHG emissions from project activity facility operations in year y (tCO_{2e})
$EC_{i,y}$	=	Electricity consumed by the project activity facility for the recovery of material type i in year y (MWh)
EF_{el}	=	Emission factor of the electric grid supplying electricity to the project activity facility (tCO_2/MWh)
f	=	Fuel type f (f = 1, 2, …, m for each type of fuel)
$FC_{f,y}$	=	Amount of fuel type f consumed by the project activity facility in year y (unit mass or volume)
NCV_f	=	Net calorific value of the fuel type f consumed in the project activity facility (GJ/unit mass or volume)
EF_f	=	Emission factor of the fuel type f consumed at the project activity facility (tCO_{2e} /GJ)

[7] https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-12-v1.pdf

4.7.5 | For projects where the project activity includes both material recovery and recycling, different types of waste streams, and/or different recyclates, facility electricity and fuel consumption data can be recorded and calculated either as a total or separately for each waste stream type w, material type i and process stage, depending on the available granularity of the facility data.

4.7.6 | Emissions associated with electricity consumption can be determined by official national grid EFs or by applying the CDM Tool 05 "Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation"[8] or the CDM Tool 07 "Tool to calculate the emission factor for an electricity system"[9] or an appropriate too approved by GS or Article 6.4 Supervisory Body. Transmission and distribution losses must be incorporated in the EF.

4.8 | Leakage emissions

4.8.1 | Leakage accounts for possible increase in GHG emissions outside the project boundary as a result of project activities.

4.8.2 | No leakage related to sourcing materials upstream is expected as, in line with the applicability criteria, it should be demonstrated that the materials diverted from the solid waste stream would otherwise have been or remain discarded i.e. reached its EoL.

4.8.3 | As some recovery and recycling processes might require the application of chemicals, respective emissions associated with the production of such need to be considered. The associated emissions from the application of chemical k in year y ($CP_{k,y}$) must be quantified by multiplying the amount of chemical k by the production EF of the chemical, which is to be determined through credible sources. If the total production emissions of all chemicals used is proven to be less than 1% of the total emissions reductions, then it can be considered de minimis, and may be disregarded.

4.8.4 | Beyond the customer, additional production processes and transportation may occur further downstream in the product manufacturing processes up to the final product consumer. Two cases are to be considered:

a. If the further product manufacturing processing steps downstream the project activity do not differ from the production using the comparable virgin materials, then emissions associated with the processes downstream of the project activity do not differ from downstream emissions in the baseline scenario. Leakage from additional production processes in this case is 0.
b. If the direct customer has additional processing steps for a recyclate that would not be necessary if the comparable virgin material was used

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[8] https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-05-v3.0.pdf

[9] https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-07-v7.0.pdf

as raw material, then emissions associated with these additional processes shall be accounted for.

4.8.5 | Leakage emissions are determined through the equation below:

$$LE_y = \sum_{k=1}^{n}(CP_{k,y} \times EF_k) + \sum_{i=1}^{n}(QD_{i,y} \times EF_{re,i}) \quad \textit{Eq. 4}$$

Where:

LE_y	=	Leakage emissions in year y (tCO_{2e})
k	=	Chemical product type
$CP_{k,y}$	=	Amount of chemical product type k applied in the recovery facility in year y (unit mass or volume)
EF_k	=	Emission factor of chemical product k used
i	=	Index for the material type
$QD_{i,y}$	=	Quantity of recyclate type i going through additional processing steps downstream in year y (t)
$EF_{re,i}$	=	Emission factor for additional recycling/additional processing steps of recyclate i (tCO_{2e}/t)

4.8.6 | EFs for additional processing steps downstream can be determined in the following ways:

a. by annual monitoring of electricity consumption and fuel consumption from the post-processing facilities, in this case:

$$EF_{re,i,y} = SEC_{re,i,y} \times EF_{el,re} + \sum_{f=1}^{m}(SFC_{re,i,y} \times NCV_{f,re} \times EF_{f,re}) \quad \textit{Eq. 5}$$

Where:

$EF_{re,i,y}$	=	Emission factor for recycling of material type i in year y
$SEC_{re,i,y}$	=	Specific electricity consumption by the recycling facility apportioned to material type i in year y (MWh/t)
$EF_{el,re}$	=	Emission factor of the electric grid supplying electricity to the recycling facility (tCO_{2e} /MWh)
f	=	Fuel type f (f = 1, 2, …, m for each type of fuel)
$SFC_{re,i,y}$	=	Specific consumption of fuel type f by the recycling facility apportioned to material type i in year y (unit mass/t or volume/t)
$NCV_{f,re}$	=	Net calorific value of the fuel type f consumed in the recycling facility (GJ/unit mass or volume)
$EF_{f,re}$	=	Emission factor of the fuel type f consumed at the recycling facility (tCO_{2e}/GJ)

b. based on the average energy consumption from conducted measurement campaigns under typical operation conditions (a campaign must last for a minimum of 10 operating days);

c. using benchmark values. These values can be obtained using relevant and credible sources as defined in section 4.11.

d. using EFs provided by the recovery/recycling facility entity; provided that they were obtained using accredited life cycle assessment methods with a verified report.

4.9 | Emission reductions

4.9.1 | The emission reductions are calculated as follows:

$$ER_y = BE_y - PE_y - LE_y \quad \text{Eq. 6}$$

Where:

ER_y	=	Emissions reductions in year y (tCO_2e)
BE_y	=	Baseline emissions in year y (tCO_2e)
PE_y	=	Project emissions in year y (tCO_2e)
LE_y	=	Leakage emissions in year y (tCO_2e)

4.9.2 | If the recovery plant is claiming emissions reductions for only part of recyclates (e.g. only for some materials and not for all of the recyclates), project emissions may be allocated to each mass unit of recyclate, that is apportioning the emissions proportional to the mass of materials leaving the project activity facility. However, cumulative total process impact still needs to be accounted for and cannot be dismissed.

4.10 | Changes required for methodology implementation in 2nd and 3rd crediting periods

4.10.1 | The definition of the baseline scenario, as well as all assumptions and all predefined EFs included in the methodology should be verified and, if necessary, be updated after every crediting period.

4.10.2 | During the crediting period renewal, changes in regional and local legislation regulation on material recovery and relevant technologies must be re-assessed and taken into account accordingly.

4.10.3 | No procedural changes are expected in the 2nd and 3rd crediting periods, unless new versions of the Gold Standard for the Global Goals Principles & Requirements require it.

4.10.4 | The latest version of the methodology shall be applied at the time of crediting period renewal.

4.11 | General requirements for data and information sources

4.11.1 | Data used in the projects must be obtained from credible and publicly available sources. The following sources are considered credible: national or local government reports, peer-reviewed scientific papers, public reports from well-established industry associations, independent expert assessments, third party verified life cycle assessments and environmental footprint declarations as well as well recognized EF databases/inventories such as Ecoinvent[10].

4.11.2 | Information on every utilised value or assumption need to be documented and publicly available (services at costs are eligible) to allow for data to be validated. The following information need to be provided in the Project Design Document Appendix:

i. type of data;
ii. author(s);
iii. year of publication;
iv. link to source or documentation;
v. rationale behind the selection.

4.11.3 | The variety of globally applicable EFs and life cycle approaches generally pose some risks. Nevertheless, these risks are mitigated in the case of metals, alloys, and minerals in the following manner:

a. Life cycle analyses can draw different system boundaries, i.e. include different stages/production processes in the supply chain. For virgin material production in this methodology, all emissions from the entire supply chain from cradle to gate may be considered to determine the EF. Any EF which does not include processes from the entire supply chain is also eligible, since this corresponds to a conservative approach in assessing baseline emissions.
b. Different EFs can vary in granularity and for example differ regarding the inclusion or exclusion of process emissions of products and co-products. Life cycle assessments of metals, alloys, and minerals present low risk for varying granularity and wrong allocation since emissions are estimated for individual materials (and not for more complex systems such as final products). If a certain EF for virgin metal or mineral production nevertheless presents low granularity, i.e. certain emissions are not accounted for, this would correspond to a conservative value.
c. The EFs used in the calculations should use values with at least three significant figures to ensure accuracy and precision.

4.12 | Data and parameters not monitored

3.12.1 | The following parameters must be available at validation and fixed throughout the crediting period:

Parameter ID	**RRMSW 1**
Data/parameter	**i**

[10] https://ecoinvent.org/the-ecoinvent-database/

Data Unit	-
Description	The specific material being recovered in the project activity, including composition and production stage description.
Source of data	Invoices, test results, documents required in applicability section
Value(s) applied	Described at the project level
Choice of data or Measurement methods and procedures	Descriptive data based on the selected sources
Purpose of data	Identification of the type of recovered material and equivalent virgin material
Additional comment	-

Parameter ID	**RRMSW 2**
Data/parameter	EF_i
Data Unit	tCO_2e/ton of material i
Description	Emission Factor for the production of virgin material type i
Source of data	See sections 4.6.3 and 4.11 for guidance.
Value(s) applied	Described at project level.
Choice of data or Measurement methods and procedures	Aligned with section 4.6.3 and described at project level.
Purpose of data	Quantification of baseline emissions.
Additional comment	-

Parameter ID	**RRMSW 3**
Data/parameter	$MR_{i,w}$

Data Unit	tons of material type i per ton of waste stream w
Description	Mandatory recovery and recycling quantity of material type i from the given waste stream w in the baseline scenario per year.
Source of data	Obtained from regional and/or national legislation. See section 4.6.4 for guidance.
Value(s) applied	The value is zero if there is no mandatory recovery and recycling quota for the recyclate in the given waste stream in the given country or region. If legislation exists, the parameter must be described at project level.
Choice of data or Measurement methods and procedures	Described at project level, aligned with section 4.6.4.1.
Purpose of data	Determination of QBi used for the quantification of baseline emissions.
Additional comment	-

Parameter ID	**RRMSW 4**
Data/parameter	$\boldsymbol{AQ_{i,w}}$
Data Unit	tons of material i per ton of waste stream w
Description	Average quantity of recovery and recycling of material type i from the given waste stream w in the baseline scenario per year
Source of data	Determined as described in section 4.6.4
Value(s) applied	Described at project level.
Choice of data or Measurement methods and procedures	Described at project level, aligned with section 4.6.4.2.
Purpose of data	Described at project level.
Additional comment	-

Parameter ID	**RRMSW 5**
Data/parameter	SF_i
Data Unit	t/t or dimensionless
Description	Substitution factor of virgin material type i per mass of recyclate. The factor is drawn from quality and purity fractions data.
Source of data	Laboratory analyses or credible sources.
Value(s) applied	Described at project level.
Choice of data or Measurement methods and procedures	Described at project level.
Purpose of data	Quantification of baseline emissions.
Additional comment	-

Parameter ID	**RRMSW 6**
Data/parameter	EQB_{iw}
Data Unit	tCO2e
Description	Emissions from baseline recovery and recycling activity of materials i from waste stream w.
Source of data	See section 4.6.5 for guidance
Value(s) applied	Described at project level.
Choice of data or Measurement methods and procedures	Described at project level, aligned with section 4.6.5.
Purpose of data	Quantification of baseline emissions.
Additional comment	-

5| Uncertainty quantifications

5.1.1 | Potential sources of uncertainty, along with the associated Quality Assurance/Quality Control (QA/QC) requirements to minimise them, are summarised in Monitoring Methodology section below.

5.1.2 | The uncertainties associated with the parameters should be aggregated into uncertainty estimates for emission reductions. A 95% confidence interval will be employed for quantifying uncertainty due to random errors, following the statistical approaches provided in the 2006 IPCC Guidelines for National Greenhouse Gas Inventories and 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (propagation of errors method). When the uncertainty in the estimated value of emission reductions is expected to be at a 95% confidence interval (within +/-10% range when applicable), the activity may exclude such random errors; while, in case of being outside +/-10% range at a 95% confidence interval, the activity should include such random errors.

5.1.3 | The project developers shall refer to applicable Gold Standard's standard document, tools, and/or activity requirements for additional guidance on uncertainty accounting and management, if available.

6| Monitoring methodology

6.1 | Data and parameters monitored

6.1.1 | The following parameters must be monitored and verified at every monitoring period:

Parameter ID	**RRMSW 7**
Data / Parameter	$QR_{i,y}$
Unit	tons of material
Description	Amount of material type i recovered and sent to a recycling or manufacturing facility downstream, or intermediary retailer in the project scenario
Source of data	Direct weighing and recording of the mass, cross checked with company records (invoices or receipts of payments)
Value(s) applied	Described at project level.
Measurement methods and procedures	Described at project level, using sources listed above.
Monitoring frequency	Annually

QA/QC procedures	See section 5.2
Purpose of data	Quantification of baseline emissions.
Additional comment	-

Parameter ID	**RRMSW 8**
Data / Parameter	EC_y
Unit	MWh/year
Description	Amount of electricity consumed by the project activity facility
Source of data	Direct measurement (electricity metre) or company records (invoices or receipts of payments)
Value(s) applied	Described at project level.
Measurement methods and procedures	Described at project level, aligned with section 4.7.3.
Monitoring frequency	Annually
QA/QC procedures	See section 5.2
Purpose of data	Quantification of project emissions.
Additional comment	-

Parameter ID	**RRMSW 9**
Data / Parameter	EF_{el}
Unit	tCO2e/MWh
Description	Emission factor of the electric grid supplying electricity to the project activity facility
Source of data	National grid EFs issued by governments are to be used if available, otherwise the CDM Tool 07 “Tool to calculate the emission factor for an electricity system” is to be used
Value(s) applied	Described at project level.

Measurement methods and procedures	Secondary data, aligned with section 4.7.3.
Monitoring frequency	Annually
QA/QC procedures	See section 5.2
Purpose of data	Quantification of project emissions.
Additional comment	-

Parameter ID	**RRMSW 10**
Data / Parameter	$FC_{f,y}$
Unit	unit mass or volume
Description	Amount of fuel type f consumed by the project activity facility
Source of data	Direct measurement or company records (invoices or receipts of payments)
Value(s) applied	Described at project level.
Measurement methods and procedures	Described at project level.
Monitoring frequency	Annually
QA/QC procedures	See section 5.2
Purpose of data	Quantification of project emissions.
Additional comment	-

Parameter ID	**RRMSW 11**
Data / Parameter	NCV_f
Unit	GJ/unit mass or volume

Description	Net calorific value of the fuel type f consumed in the project activity facility
Source of data	IPCC
Value(s) applied	Described at project level.
Measurement methods and procedures	Secondary data
Monitoring frequency	Updated according to the latest IPCC publication
QA/QC procedures	See section 5.2
Purpose of data	Quantification of project emissions.
Additional comment	-

Parameter ID	**RRMSW 12**
Data / Parameter	EF_f
Unit	tCO_2e/GJ
Description	CO_{2e} emission factor of the fuel type f consumed at the project activity facility
Source of data	IPCC
Value(s) applied	Described at project level.
Measurement methods and procedures	Secondary data
Monitoring frequency	Updated according to the latest IPCC publication
QA/QC procedures	See section 5.2
Purpose of data	Quantification of project emissions.
Additional comment	-

Parameter ID	**RRMSW 13**
Data / Parameter	TW_y
Unit	tCO_{2e}
Description	CO_{2e} emissions from the transport of waste
Source of data	See section 4.7.4. Distances can be obtained from maps
Value(s) applied	Described at project level.
Measurement methods and procedures	Described at project level, aligned with section 4.7.4.
Monitoring frequency	Once for every transport route
QA/QC procedures	See section 4.7
Purpose of data	Quantification of project emissions.
Additional comment	-

Parameter ID	**RRMSW 14**
Data / Parameter	TR_y
Unit	tCO_{2e}
Description	CO_{2e} emissions from the transport of recyclates
Source of data	See section 4.7.4. Distances can be obtained from maps
Value(s) applied	Described at project level. May be zero if proven de minimis.
Measurement methods and procedures	Described at project level, aligned with section 4.7.4.
Monitoring frequency	For every transport route
QA/QC procedures	See section 4.7
Purpose of data	Quantification of project emissions.

Additional comment	-

Parameter ID	**RRMSW 15**
Data / Parameter	QD_i
Unit	tCO2/t
Description	Quantity of recyclates i going through additional processing steps downstream
Source of data	See options in section 4.8.2
Value(s) applied	Described at project level.
Measurement methods and procedures	Described at project level.
Monitoring frequency	Annually
QA/QC procedures	See section 5.2
Purpose of data	Quantification of leakage emissions.
Additional comment	-

Parameter ID	**RRMSW 16**
Data / Parameter	$EF_{re,i}$
Unit	tCO_2/t
Description	Emission factor for recycling of recyclate i
Source of data	Follow options in section 4.8.6
Value(s) applied	Described at project level.
Measurement methods and procedures	Described at project level.
Monitoring frequency	To be updated if new values are available.

QA/QC procedures	See section 5.2
Purpose of data	Quantification of leakage emissions.
Additional comment	-

Parameter ID	**RRMSW 17**
Data / Parameter	CP_k
Unit	Volume or mass
Description	Amount of chemical product k used in the project activity
Source of data	Invoices or delivery receipts
Value(s) applied	Described at project level.
Measurement methods and procedures	Described at project level.
Monitoring frequency	If new values available
QA/QC procedures	See section 5.2
Purpose of data	Quantification of leakage emissions.
Additional comment	May be de minimis.

Parameter ID	**RRMSW 18**
Data / Parameter	EF_k
Unit	tCO2e/volume or mass
Description	Emission factor for production of chemical k
Source of data	Product LCAs or credible EF databases
Value(s) applied	Described at project level.
Measurement methods and procedures	Secondary data

Monitoring frequency	To be updated if new values are available.
QA/QC procedures	See section 5.2
Purpose of data	Quantification of leakage emissions.
Additional comment	-

Parameter ID	**RRMSW 19**
Data / Parameter	OW_w
Unit	t
Description	Amount of waste from waste stream w delivered to project facility
Source of data	Direct weighing or company records (invoices or receipts of payments)
Value(s) applied	Described at project level.
Measurement methods and procedures	Described at project level.
Monitoring frequency	Annually
QA/QC procedures	See section 5.2
Purpose of data	Not used to calculate emissions reductions, but rather as a safeguard as it is part of the applicability conditions.
Additional comment	-

6.2 | General requirements for sampling

6.2.1 | Documents required as per applicability section must be provided upon project validation. However, any new types of waste streams, recyclates, or customers must be reported in the monitoring period and verified.

6.2.2 | During the crediting period, all parameters listed in section 5.1 must be monitored and recorded. The record-keeping practices must be established and include details on the following:

i. data and information to be reported;

ii. data units;

iii. data sources;
iv. monitoring methods (e.g., estimation, modelling, measurement and calculation);
v. monitoring equipment, if applicable;
vi. monitoring frequencies;
vii. QA/QC procedures; and
viii. Responsible staff for data collection.

6.2.3 | Monitoring and weighing equipment must be maintained and calibrated according to current good practice (e.g., relevant industry standards or manufacturer specifications) or at least every three years.

6.2.4 | Monitoring roles and responsibilities must be clearly defined in the project description. Moreover, monitoring personnel must be trained to ensure that monitoring requirements are carried out in accordance with the monitoring plan.

6.2.5 | All data collected as part of the monitoring must be archived electronically and stored in a secure and retrievable manner for at least two years after the end of the project crediting period. Applying FAIR principles is encouraged.

6.2.6 | QA/QC procedures must be applied to increase confidence that all measurements and calculations have been made correctly. These include, but are not limited to:

i. data gathering, input, and handling measures;
ii. checking input data for typical errors, including inconsistent physical units and unit conversion errors;
iii. detecting typographical errors caused by data transcription from one document to another, and missing data for specific time periods or missing physical units;
iv. checking input time series data for large, unexpected variations (e.g., orders of magnitude) that could indicate input errors; and
v. physical protection of monitoring equipment (e.g., sealed metres and data loggers).

7| Other

7.1 | Evaluation of similar methodologies

7.1.1 | Similar methodologies were analysed and are presented in the table below.

Methodology	Title	GHG Program	Comments

AMS-III.AJ.[11]	Recovery and recycling of materials from solid waste	Clean Development Mechanism	Only the recovery and recycling of the metals aluminium and steel are covered by this methodology. The source of waste is limited to municipal solid waste. The methodology is only applicable to non-Annex 1 countries
AMS-III.BA.[12]	Recovery and recycling of materials from e-waste - Version 3.0	Clean Development Mechanism	Only recovery and recycling of several metals from e-waste are covered by this methodology. The methodology is only applicable to non-Annex 1 countries.

7.2 | Considerations in case of applying methodology in PoA

7.2.1 | The methodology can be applied in a PoA, provided that every VPA fulfils the applicability conditions and clearly defines the materials recovered.

7.2.2 | A PoA shall consist of VPAs utilising the same kind of technology. Nevertheless, the specific type of materials recovered and the waste stream source may differ.

7.3 | Additional requirements for 'Sustainable Development Goals'

7.3.1 | To demonstrate additional SDG impacts, the project proponent should follow the Gold Standard SDG impact tool manual and requirements[13].

7.3.2 | The SDGs assessment is conducted at the project level. No additional requirements are necessary in this methodology.

DOCUMENT HISTORY

Version	Date	Description
1.0	02 May 2025	First version

[11] https://cdm.unfccc.int/methodologies/DB/LOWIXM9S6DVO7DGXB21DPVLE8N3VB9

[12] https://cdm.unfccc.int/methodologies/DB/TO0E8JPL9361FDB1IPF0TUPS0WJXV3

[13] https://globalgoals.goldstandard.org/430g-iq-sdg-impact-tool-manual/