Proba World BV
Laan van Kronenburg 14
1183 AS Amstelveen
The Netherlands

Methodology:

Use of waste recovery to transition to a circular economy

16 June, 2025

Methodology ID	PM.0006
Version	0.9
Status	Draft methodology (public consultation)
Type	New methodology
Developer	Proba World BV
Contact Information	methodologies@proba.earth

Table of contents

List of definitions

Additionality	Refers to the concept that any GHG project should result in greenhouse gas emissions mitigation (GHG reductions or removals) that would not have occurred without the project. In other words, the project's positive impact on reducing or removing emissions should be "additional" to what would have happened under the baseline scenario.
Baseline scenario	The baseline scenario represents the greenhouse gas emissions that would occur in the absence of the project intervention. It reflects the most likely set of activities, technologies, and practices that would continue under business-as-usual conditions, without the implementation of the proposed project.
Buffer pool	A Buffer Pool is a shared reserve of Carbon Credits established to cover potential losses in GHG Projects, ensuring the integrity of emission reductions or removals over time. Each GHG Project contributes to Proba's Buffer Pool when Carbon Credits are being issued. These Carbon Credits can only be used by Proba to compensate for reversals.
Carbon credit (emission reduction certificate)	A carbon credit represents at least 1 tonne of CO_2 (tCO_2), or 1 tonne of CO_2e (tCO_2e) reduced or removed for a certain period of time. One tonne (metric ton) (t) equals 1000 kg. For carbon equivalency, Proba uses the AR-6 assessment from UNFCCC[1] (see Appendix B: CO_2e and Global Warming Potential).
Carbon dioxide equivalent - CO_2e	A metric used to compare the emissions of various greenhouse gases based on their Global Warming Potential (see GWP definition). It expresses the impact of different gases in terms of the equivalent amount of CO_2, facilitating a standardized approach to assessing overall greenhouse gas emissions.
Conservativeness	When there is uncertainty or a choice between two or more assumptions, values, methodologies, or procedures, the option that is more likely to result in lower estimates of GHG emission reductions or removals must be selected. This approach ensures that claimed climate benefits are not overestimated.
Cradle-to-gate	A life cycle assessment boundary that includes all greenhouse gas emissions associated with a product's life cycle stages up to the point it reaches the project's location. This includes emissions from raw material extraction, production, and transportation to the project's location. It excludes emissions from field application or any subsequent stages beyond the project's location.

[1] https://ghgprotocol.org/sites/default/files/Global-Warming-Potential-Values%20%28Feb%2016%202016%29_0.pdf

Crediting period	The "crediting period" refers to the specific duration of time during which a GHG project is eligible to generate and issue emission reduction certificates for the GHG emissions it reduces or removes. This period is predefined and ensures that the project's emissions impact is monitored, verified, and credited only within that set timeframe. A crediting period can be renewed once or multiple times.
Emission factors	Emission factors are coefficients that quantify the amount of greenhouse gases released into the atmosphere per unit of activity, substance, or process. They are essential tools in calculating emissions and facilitating the estimation of a project's total greenhouse gas emissions. The Intergovernmental Panel on Climate Change (IPCC) has established a three-tier system for the development and application of emission factors (Tier 1, Tier 2, and Tier 3). These tiers are presented in Appendix A: Data selection.
GHG project	Activity or activities that alter the conditions of a GHG Baseline and which cause GHG emissions reductions or GHG removals. The intent of a GHG project is to convert the GHG impact into emission reduction certificates.
Global Warming Potential (GWP)	The time-integrated radiative forcing resulting from a pulse emission of a specific greenhouse gas, relative to the radiative forcing from a pulse emission of an equivalent mass of carbon dioxide (CO_2). It provides a common scale to compare the climate impact of different gases over a specific time horizon, typically 100 years.
Insetting	Insetting refers to the practice of implementing sustainability interventions within a company's own value chain to reduce greenhouse gas (GHG) emissions or enhance carbon sequestration. Unlike offsetting, which typically involves purchasing carbon credits for activities outside the value chain, insetting focuses on reducing emissions directly linked to the company's operations, suppliers, or production processes.
IPCC	The Intergovernmental Panel on Climate Change is a United Nations body, assessing science related to climate change to provide policymakers with regular scientific updates.
Leakage	In the context of a GHG project, leakage refers to the unintended increase in greenhouse gas emissions outside the project boundaries as a direct result of the project's activities.
Offsetting	Offsetting refers to the practice of compensating for greenhouse gas (GHG) emissions by supporting projects outside a company's value chain that reduce or remove emissions. This is typically achieved by purchasing carbon credits from verified

	initiatives.
Proba Standard	The Proba Standard aims at controlling and reducing the risks related to GHG projects, their climate impact (emission reduction) and the corresponding issuance of emission reduction certificates and subsequent claims. It does so by relying on and aligning with internationally recognized standards frameworks and initiatives such as the Core Carbon Principles by the ICVCM and the ICROA Code of Best Practice. The Proba Standard sets out detailed procedures for identification and validation of GHG projects, and verification of emission reductions and removals, based on ISO 14064-2 . More information about the Proba Standard can be found at https://proba.earth/document-library.
Product Carbon Footprint (PCF)	The total amount of greenhouse gases (GHGs) emitted directly or indirectly by a product throughout its life cycle. It is typically measured in units of carbon dioxide equivalents (CO_2e) to account for the varying global warming potentials (GWP) of different GHGs.
Project boundaries	The project boundaries of a GHG project delineate the spatial, temporal, and operational limits within which the GHG emissions, reductions, and removals are quantified and monitored, encompassing specific activities, sources, sinks, and reservoirs related to the project.
Project Overview Document (POD)	A document that offers a detailed summary of a GHG project's key elements, including governance, emission calculations, risk management, methodologies, and monitoring processes (see Proba Standard).
Tier 1, 2 and 3	In the context of greenhouse gas (GHG) emissions reporting and inventory management, data and methodologies are categorized into three tiers (Tier 1, Tier 2, and Tier 3), as defined by the Intergovernmental Panel on Climate Change (IPCC). These tiers represent varying levels of accuracy, data specificity, and complexity. For more information see Appendix A: Data selection.
Verification and Validation Bodies (VVBs)	Third-party assurance entities, preferably ISO-accredited, are responsible for verifying that a project's activities and claims of emissions reductions and/or removals are conducted in accordance with established standards and methodologies, ensuring their accuracy and credibility.
Waste recovery	Waste recovery is defined as the use of wastes as an input material to create valuable products as new outputs. The aim is to reduce the amount of waste generated.

List of abbreviations

AR-6	IPCC Sixth Assessment Report
EF	Emission Factor
GHG	Greenhouse Gas
IPCC	Intergovernmental Panel on Climate Change
LCA	Life Cycle Assessment
LDC	Least Developed Countries
MRV	Monitoring, Reporting, and Verification
PCF	Product Carbon Footprint
POD	Project Overview Document
SDG	Sustainable Development Goal
SIDS	Small Island Developing States
VVB	Verification and Validation Body

1 Introduction

1.1 Background

The disposal of waste through landfilling, open burning, and incineration remains a major environmental and climate issue. According to the IPCC, methane emissions from solid waste disposal sites are the largest source of greenhouse gases in the waste sector, while incineration and open burning of fossil-based waste, such as plastics, are the primary sources of carbon dioxide[2]. These end-of-life practices not only lead to the significant release of greenhouse gases but also result in the permanent loss of materials that could otherwise be recovered. At the same time, the continued extraction and processing of virgin raw materials to meet industrial demand contributes significantly to global emissions and resource depletion. Recovering waste into usable products plays a critical role in reducing net greenhouse gas emissions. It allows for the avoidance of emissions from conventional disposal routes while also displacing the need for emissions-intensive virgin materials. By extending the life of materials following 9 circular economy 'R' strategies or principles[3] waste recovery directly supports the transition to a circular economy.

Effective climate impact, however, depends on more than just recovering waste. It requires systems that ensure the recovered output is of sufficient quality to replace virgin equivalents, is traceable through the value chain, and does not cause unintended consequences such as leakage. Effective sorting, processing, and documentation are necessary to maintain the integrity of such interventions.

This methodology provides a framework for measuring and accounting for emission reductions resulting from the recovery of waste. It applies to both offsetting and insetting use cases, enabling companies and project developers to credibly quantify the climate benefits of circular economy interventions and support the Scope 3 decarbonization efforts, and contribute to broader sustainability transitions.

1.2 Applicability of the methodology

- This methodology applies globally to interventions that recover waste to transition to a circular economy.

[2] 2006 IPCC Guidelines for National Greenhouse Gas Inventories: https://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/5_Volume5/V5_1_Ch1_Introduction.pdf
[3] Categorisation System for the Circular Economy - European Commission (2020): https://circulareconomy.europa.eu/platform/sites/default/files/categorisation_system_for_the_ce.pdf

    - Waste recovery refers to the process of extracting value from waste materials by converting them into products, components, or feedstocks that can replace virgin resources in the economy. It includes a range of interventions such as recycling, upcycling, refurbishing, reprocessing, and other methods that allow waste to serve a new functional purpose.
- Project developers must ensure that the applicability, eligibility and additionality criteria presented in this methodology are fulfilled.
- This methodology is applicable to both offsetting and insetting projects. In alignment with emerging SBTi guidance, insetting projects should prioritize direct mitigation, where the intervention can be physically linked to specific emissions sources within the company's value chain through a robust chain of custody model. Where such traceability is not yet possible, indirect mitigation may be used as an interim measure, provided it supports the transformation of the relevant value chain over time.
- Project developers must be able to demonstrate that without the intervention (e.g., baseline scenario), there would be activities related to the production, transportation, usage or end-of-life (EOL) of products, which would lead to GHG emissions.
- Project developers must prove that because of the intervention (e.g., project or program), the recovery of waste leads to the reduction of the net GHG emissions.
- For both the baseline and project intervention, project developers must provide proof of the emission factors (EFs) related to the specific characteristics and activities of the project.
- The waste must be collected or diverted from:
    - landfill
    - open burning
    - incineration (with or without energy recovery)
    - any other disposal or recovery route that would prevent the material from retaining more of its original value or function, such as low-efficiency recycling.
    - In some cases, the waste may be diverted from existing recycling pathways if the intervention demonstrably leads to a greater net reduction in GHG emissions—e.g., through refurbishment or reuse that preserves more embedded energy and function. The project developer must provide comparative evidence of the emissions performance between the baseline (e.g., recycling) and the project scenario (e.g., refurbishment).
- Project developers must ensure that the waste streams are properly sorted so that the recovery process handles only relevant materials.
    - Project developers must document how sorting is done and demonstrate that the sorted waste meets the needs of the chosen recovery technology. For example:

        - For mechanical recycling, sorted material should meet size, cleanliness, or polymer-type specifications.
        - For chemical or advanced processes (pyrolysis, depolymerization), sorting criteria should ensure minimal incompatible materials or hazardous contaminants.
    - Project developers must ensure only the relevant and recoverable fractions proceed, while contaminants, non-target materials, and hazardous substances are removed or managed separately. The fraction of the waste not meant to be recovered must be removed or treated according to relevant regulations, and cannot be included as part of the recovered output.
    - Project developers must demonstrate that their chosen method reliably produces a feedstock appropriate for the recovery technology and ensures traceability of sorted fractions. The methodology does not dictate one “correct” sorting approach.
- In case composite or hybrid fractions are used, these must not be mixed with higher-purity or easily recoverable streams, if doing so diminishes or prevents those purer fractions from being recovered in the future.
    - Mixing is allowed if the project developer demonstrates that:
        - A. No better standalone recovery pathway exists for the composite fraction, **and**
        - B. Overall environmental benefit is greater (e.g., higher virgin displacement, lower net GHG emissions) than disposing of the composite fraction entirely.
- Project activities must lead to waste being recovered through:
    - installing of a new recovery facility
    - expanding or upgrading existing recovery capacity
    - increasing collection/sorting of waste so that more of it is recovered
    - redirecting a waste stream towards the waste recovery method
- The methodology does not restrict waste recovery processes (mechanical processes such as shredding, melting or chemical recycling such as pyrolysis, depolymerization) to a fixed set of technologies, as long as they meet core criteria of improving resource recovery and displacing raw inputs.
- The recovered waste must effectively replace the baseline product in delivering the same function. To ensure a fair comparison between the project and baseline scenarios, a functional unit must be defined. This is the quantifiable output or service the product is intended to provide (e.g., one ton of insulation material, one cubic meter of packaging, etc.). Emission calculations in both the baseline and project scenarios must be based on this functional unit.

- The project developer must ensure that recovered waste is weighed or quantified at the facility’s exit gate (or at the earliest practical point).
  - For chemical or otherwise decomposed outputs (e.g., pyrolysis oil, devulcanized material), use mass-balance or similar methods to attribute the recovered fraction to the correct material types.
  - Any non-recoverable leftovers or processing residues must be managed responsibly. This includes preventing uncontrolled emissions or discharges, minimizing environmental harm, and complying with applicable waste handling and disposal regulations. The project developer must justify the selected disposal route and ensure it meets comparable environmental standards.
- This methodology can work **synergistically** with other GHG methodologies or programs that target emissions reductions or removals in areas outside the scope of this methodology. In case this methodology is used in conjunction with other methodologies or programs then the project developer must:
  - explicitly mention that in the POD and
  - demonstrate that benefits are not quantified more than once (to mitigate the risk of double counting)
  - provide a separate monitoring framework to ensure that combined interventions do not undermine each other's effectiveness in long-term consistency
- This methodology has been developed in accordance with the Proba Standard, ensuring that all guidelines, principles, and requirements outlined in the standard are fully adhered to. Users of this methodology are expected to follow the Proba Standard to ensure consistency, credibility, and compliance with the broader framework established by Proba.

1.3 Eligibility

1.3.1 Types of waste to be recovered

- In this methodology, the eligible waste streams are those destined for disposal (e.g., landfill, incineration, open burning, etc.) and are thereby prevented from getting recovered. Waste streams that are already being recycled may also be eligible if the proposed intervention demonstrably leads to a net reduction in greenhouse gas emissions compared to the existing recycling pathway.
- The following waste streams are eligible:
  - Post-production: by-products or scraps generated during the manufacturing and production process
  - Post-consumer: waste that results after a product has served its intended purpose and is no longer wanted or needed by the end user
- The methodology applies to any type of waste that meets the above criteria, regardless of material type.
- The following waste streams are non-eligible:
  - Materials that are already being diverted to high-quality recovery channels or reused without significant transformation (e.g., simple resale of used products).
  - New, unused products generated from overproduction, which do not arise from actual waste diversion

1.3.2 Types of recovered products

- The recovered products must be functionally equivalent to its virgin counterpart. This means they must meet the necessary performance standards for its intended application.

1.3.3 Regulatory compliance

- Project developers must provide proof to show that the recovery processes as well as the recovered products meet local and international safety, quality, and environmental standards. This also includes managing hazardous components or contaminants according to established protocols.
- Compliance to regional and national guidelines is mandatory.

1.4 Additionality

Additionality refers to the concept that a GHG reduction project should result in emissions reductions beyond what would have occurred under a "business-as-usual" scenario or existing regulations, ensuring the reductions are truly "additional" and not simply complying with mandatory requirements.

Depending on whether the project developer aims to use the generated claims (emission reduction certificates) in either offsetting or insetting scenarios, different requirements apply.

For the offsetting scenario the project developer must prove the following three aspects of additionality:

- Regulatory additionality: The project developer must prove that the intervention was not caused by local, regional or national regulations.
    - To achieve that, the project developer must prove that there is a) no regulation mandating the recovery of the waste stream and b) there is a lack of financial incentive of regulatory directives to realize the proposed intervention. If subsidies are available, the project developer must show that available funding does not cover the financial gap to realize the intervention.
    - If a project falls under planned regulations, additionality can still be achieved if the project can prove its intervention goes beyond the set goals or realizes its impact ahead of the planned regulation timeline. In this case, the project may only be additional for a limited time until the regulation comes into effect and becomes business-as-usual.
    - If a regulation is implemented and actively enforced during the crediting period that mandates the recovery of products, the crediting period for the project will end at that point, as the project would no longer meet the criteria for additionality.
- Prevalence: The project developer must prove that the intervention is not a common practice in each region included within the project area. Common practice is defined as per the guidelines of the Standard that the project developer follows. For instance, this can be achieved by:
    - Demonstrating that manufacturers in the region typically opt for virgin inputs due to factors like reliability, quality concerns, or pricing.
    - Providing evidence (e.g., surveys, interviews, industry reports) showing low adoption of recovered feedstock under normal market conditions.
    - Identifying key obstacles (e.g., inconsistent supply, lower quality, lack of standards) that hinder the use of recovered materials.

  - Showing how the project overcomes these barriers (e.g., improved sorting, better quality control, stable supply contracts).
  - For that purpose, a financial analysis can be provided, that calculates costs and benefits, and compares financial aspects between a GHG Project, the chosen baseline, and possible alternative scenarios. Project developers can use the tool developed by the Carbon Development Mechanism (CDM) titled "*Combined tool to identify the baseline scenario and demonstrate additionality*"[4] for this purpose. This financial analysis may be treated as confidential by the VVB and Proba and is not required to be published in the public registry.
- Financial additionality: The project developer must prove that the financial incentive from carbon finance will lead to the adoption of the waste recovery method. Financial additionality is also achieved when the carbon finance improves the business case of a project allowing it to scale and accelerate the scope of the project.

For the insetting scenario, the Project Overview Description (POD) must be transparent and document information on:

- Regulatory Additionality: The project developer must confirm that the use of the waste recovery method is not mandated by the regulation.
- Prevalence additionality: An explanation must be provided that the use of the waste recovery method is not a common practice within the company's sourcing region or market segment relevant to the intervention.
- Financial additionality: An explanation must be provided that carbon finance is positively affecting the use of the waste recovery method within the company's sourcing region or market segment.

Note: Additionality must be reassessed when renewing the crediting period to confirm that the project remains eligible under the Proba Standard. Project developers are responsible for monitoring regulatory changes, financial conditions, and market adoption that may affect the project's additionality. The use of a dynamic baseline is required to reflect these developments and ensure the continued credibility of the emission reductions being claimed, as seen in section 3 Baseline scenario.

[4] https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-02-v7.0.pdf

1.5 Crediting period

The crediting period is the timeframe during which a validated project can generate emission reduction certificates. After the end of the crediting period, the project needs to be re-validated, to ensure that additionality is still present, the baseline scenario is reassessed, and the project complies with the latest version of this methodology.

For GHG projects recovering waste, the crediting period can be set up to a **maximum of 10 years**, depending on the trend in regulatory and industry landscapes towards circular economy practices. This duration strikes a balance between providing enough time for projects to demonstrate their environmental impact and maintaining flexibility for project adjustments and improvements (e.g., new technologies or regulations).

Retroactive crediting

This methodology allows for retroactive crediting, in case the waste recovery was realized within a maximum of **two years** prior to the submission of the validation of the POD.
In such cases, the crediting period will begin at the moment the intervention was first implemented, provided that the project developer can fulfill the requirements set by this methodology (e.g., proof of additionality, baseline, scientific evidence, documentation etc.) and in addition demonstrate that the intervention was implemented with the intention of utilizing carbon finance.

1.6 Co-benefits & no harm principle

This methodology does not prescribe any calculation methods for quantifying additional benefits resulting from the recovery of waste. Project developers are recommended to report on co-benefits for credibility purposes.

Proba encourages GHG projects to contribute to at least one or more UN Sustainable Development Goals, and expects that project developers will consider these when preparing and designing a project.

If the project developer aims to claim one or more co-benefits, these must be clearly defined in the Project Overview Document (POD), along with how the impact is achieved, measured (e.g., through KPIs[5]). In this case, relevant KPIs must be selected by the project developer and monitored throughout the years.

---

[5] KPIs (Key performance indicators) measure a company's success vs. a set of targets, objectives, or industry peers

Project developers must adhere to the "*Environmental and Social do no harm principle*" by conducting thorough assessments to identify and evaluate potential environmental and social impacts of their GHG projects.

They must implement appropriate mitigation measures to address any identified potential risks and negative impacts, ensuring that the project does not adversely affect local ecosystems or communities, particularly vulnerable populations.

The Project Developer can use the *Risk Evaluation Template for waste-valorisation projects*[6] to report the risk assessment systematically along with the risks outlined in section 1.7 Risks.

Continuous monitoring and adaptive management strategies must be employed to ensure ongoing compliance with this principle throughout the credit period (and beyond if necessary). This process must be clearly defined and explained in the Project Overview Document (POD).

Project developers are encouraged to engage in projects that help underserved regions (like many LDCs or SIDS) that lack adequate local recycling.

1.7 Risks

The project developer must provide:

- a **risk analysis** that identifies every potential risk factor that may cause the project to under/over-deliver against its stated GHG reduction claims. Using the *Risk Evaluation Template for waste-valorisation projects* [6] the developer must evaluate each risk, assign both a likelihood score and a severity score, and justify those scores in writing.
- a **mitigation strategy** that outlines the preventive controls for all identified risks . Any risk receiving a "high" or "very high" combined score must be covered by a mitigation plan that specifies *both* preventive controls and corrective actions. This strategy must describe in detail how the developer will mitigate, monitor, report on, and, when required, compensate for any technical, environmental, or social harm arising from the risk. For certain risks that pose significant environmental or social concerns, the developer may be asked to supply further evidence in support of the mitigation approach.

[6] The template can be shared upon request and is intended only as guidance. It is the developer's responsibility to complete the full risk assessment, and either the developer or the VVB may introduce additional project-specific risks that should be considered.

1.8 Leakage & permanence

Leakage in the context of a GHG project is the net increase in GHG emissions that occur outside the project boundary (see section 2 Project boundary), directly resulting from the project's activities (IPCC, 2006). The table below outlines the main categories of leakage relevant to waste recovery projects. For each type of leakage, it defines the conditions under which the risk arises, when it can be considered negligible, and what project developers must do to assess and address it.

Table 1: Leakage Risks, Conditions for Negligibility, and Required Actions

Leakage Risk	*Description*	*When can it be considered negligible?*	*What must the project developer do?*
Displacement of existing recovery and market leakage	The project diverts waste that would otherwise be recovered or recycled by other users, forcing them to substitute with more emissions-intensive virgin materials.	• The waste was destined for disposal (e.g. landfill, incineration) and had no prior recovery use or economic value, or • total waste supply exceeds demand, or • alternative secondary materials are available that do not increase emissions.	• Assess the prior fate of the waste stream and document any existing recovery uses • Evaluate potential disruption to other users and whether alternative inputs exist • Apply a tiered deduction (see below) if risk of displacement or substitution cannot be ruled out
Activity shifting	Project activities lead to the relocation of carbon-emitting processes (e.g., use or disposal) to less regulated regions or outside the project boundary.	• Use, processing, or disposal of recovered products stays within the same regulatory/infrastructure context, or risks are mitigated via end-of-life safeguards.	• Identify potential cross-border shifts in activities. Implement traceability or safeguards. Monitor and document any relocation of emissions-related processes.

<u>Tiered deduction to account for displacement of existing recovery</u>

- To conservatively account for the risk of market leakage from the displacement of waste materials already in use or recovery, project developers must assess the likelihood of leakage in the Project Overview Document (POD). Based on this assessment, the following tiered default deductions must be applied to the project's calculated emission reductions at the time of emission reduction certificate issuance:

Table 2: Leakage risk tiered deduction

Leakage Risk Level	*Example Conditions*	*Deduction*
Low	Low likelihood that the recovered waste stream would have been used by other recovery or recycling systems. The project does not compete with existing secondary markets or displace users of recycled content. Typically applies to small- or medium-scale projects.	0%
Medium	Uncertainty around the prior fate of the waste or its potential diversion from informal or partially documented recovery channels. Some risk that the intervention may compete with or affect existing secondary material users.	5%
High	High likelihood that the recovered waste displaces feedstock already used in established recycling or recovery systems, leading to potential substitution with virgin materials elsewhere. Often relevant for large-scale projects or those in regions with constrained waste supply and developed recovery markets.	10%

- This deduction is reversible. After a period of **four years**, the project developer may submit evidence demonstrating that the project did not result in material displacement, market disruption, or increased virgin material use elsewhere. If this evidence is accepted by the verification body or program authority, the previously deducted emission reductions may be credited retroactively or released from a buffer pool. If adequate evidence is not provided, the deduction remains permanent.

1.8.2 Permanence

The intervention focuses on the reduction of GHG emissions through the diversion and recovery of waste materials that would otherwise decompose or be incinerated, leading to emissions. Once the waste is recovered in a way that prevents its degradation or combustion, the potential for it to emit greenhouse gases (such as CH_4 or CO_2) is permanently avoided for that waste stream.

Since these reductions result from a one-time prevention of emissions, rather than carbon sequestration or storage, the risk of reversal is not applicable.

2 Project boundary

2.1 Scope of activities

This methodology applies to project activities that recover waste materials otherwise destined for disposal (e.g., landfill, incineration, open burning), and reintroduce them into manufacturing processes as substitutes for virgin raw materials.

Project activities in scope include:

1. Recovery of internal post-production waste (stream X)
2. Recovery of internal post-consumer waste (stream Y)
3. Recovery of external post-production waste (stream Z)
4. Recovery of external post-consumer waste (stream W)

The project must demonstrate that the recovered material replaces virgin input or avoids disposal emissions. All four waste streams are eligible as long as they meet the criteria defined in Section 1.3 Eligible products and result in net GHG emission reductions. The intervention may lead to both avoided and added emissions across different lifecycle stages, as shown in *Figure 1.*

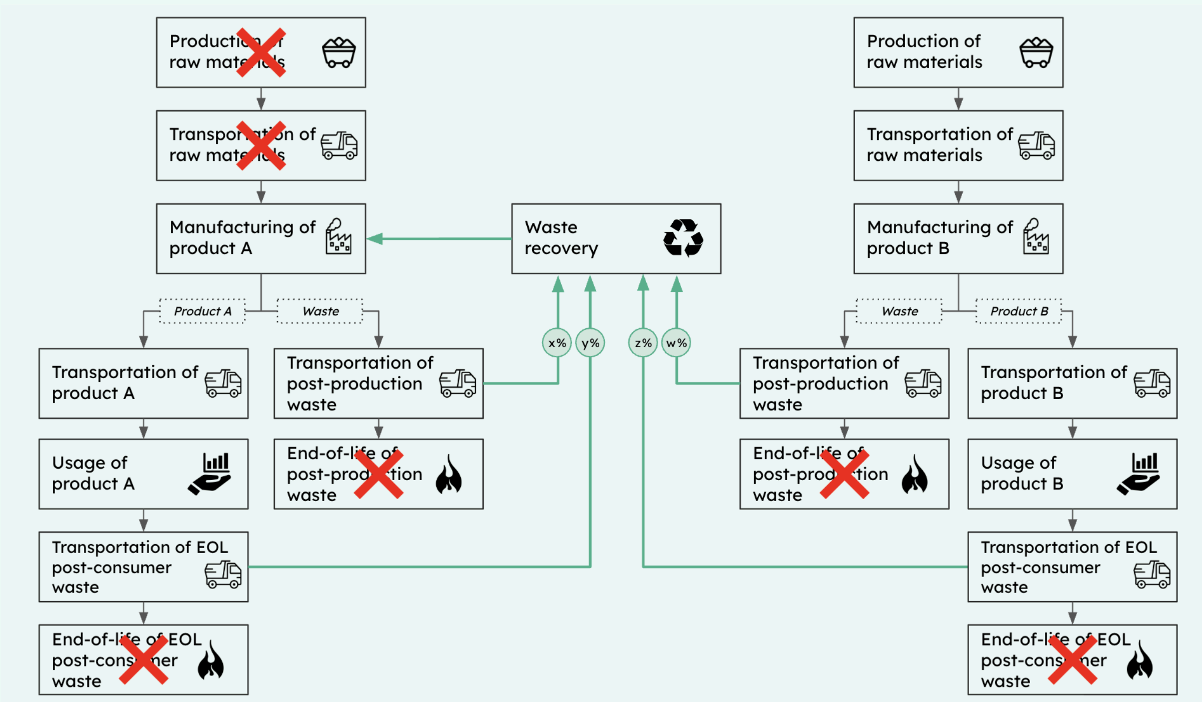

Figure 1: Scope of interventions based on the source of the waste.

Note: An activity marked with a red *X* on *Figure 1* means that the emissions related to the marked activity are avoided. Of course, the avoidance may apply only to a portion of the total waste stream. This is the case when only part of the recovered material is of sufficient quality or traceability to be used as a direct substitute for virgin materials. In such cases, the emission reductions from avoided raw material use must be quantified proportionally, based on the share of the recovered output that demonstrably displaces virgin input.

2.2 GHG sources

This methodology covers the GHG emissions associated with each relevant stage impacted by the intervention. Depending on the specific project setup and data availability, the following emission sources may be included:

Table 3: Emission sources covered under this methodology

Activity / Source	*GHG*	*Included*	*Justification*
(1) Production of raw materials (baseline only)	CO_2e	Yes	Avoided emissions from extraction and processing of virgin materials.
(2) Transportation of materials	CO_2	Yes	Changes in transportation emissions due to new collection, processing, or product delivery routes.
	CH_4/N_2O	No	Typically not material for transportation activities.
(3) Waste recovery process	CO_2e	Yes	Emissions from sorting, cleaning, mechanical or chemical recycling.
(4) Manufacturing of final product (if affected)	CO_2e	Conditional	Only included if recovered inputs cause a change in manufacturing emissions (e.g., processing energy).
(5) End-of-life treatment of waste	CO_2, CH_4, N_2O	Yes	Emissions avoided by preventing landfill, incineration, or open burning of waste.

The type and magnitude of emissions in scope can vary significantly depending on the material type, disposal method, recovery process, and industry context. For example, methane (CH_4) emissions may be relevant for organic waste sent to landfill, while CO_2 may dominate in energy-intensive material production, and N_2O may be associated with certain chemical processes. It is the responsibility of the project developer to identify and include the relevant GHGs for their specific project, based on material characteristics, intervention type, and applicable emission factors.

For some waste streams, only part of the recovered output may be suitable for direct substitution of virgin materials. In such cases, emission reductions from avoided raw material use must be quantified proportionally.

All emissions must be reported in CO_2-equivalent (CO_2e) units, using activity-specific emission factors where available.

2.3 Spatial boundaries

The spatial boundaries of a project are defined by the geographic areas where activities occur that impact greenhouse gas (GHG) emissions. These must include all relevant locations involved in the lifecycle of both the recovered and the baseline (conventional) product.

Project boundaries must account for the following stages:

- **Raw material and waste source locations**: This includes virgin material extraction or production sites in the baseline scenario, as well as all locations where waste is generated or collected. Examples include manufacturing plants producing off-spec or rejected (post-production) material, and municipal or industrial post-consumer collection points.
- **Sorting facilities**: If sorting is conducted separately from the recovery process, these facilities must be included, as they influence material quality, recovery rates, and related emissions.
- **Processing and manufacturing sites**: These include waste recovery plants where shredding, granulating, chemical recycling, or remanufacturing occurs, as well as baseline manufacturing facilities that would have used virgin raw materials in the absence of the project.
- **Product distribution and downstream supply chain**: If the project intervention affects warehousing, packaging, or distribution (e.g., due to changes in volume or logistics), those emissions must be included.
- **Usage sites (if applicable)**: If the recovered product is used in a specific application with geographically defined impacts (e.g., construction materials, packaging, components) that leads to different emissions compared to its virgin counterpart, these locations must be part of the boundary, particularly when relevant for assessing performance or end-of-life scenarios.
- **End-of-life management**: If the upcycled or recycled product differs in end-of-life fate compared to its virgin counterpart, this must be reflected. This includes disposal pathways such as landfill, incineration, reuse, or further recycling.
- **Transportation between stages**: All relevant transport emissions between the above stages must be included. This encompasses waste collection, raw material transport, movement of intermediate products, and final product distribution.

The spatial boundary is flexible in scale, as it may involve one facility or span multiple sites and countries, so long as all relevant emission sources and impacts are captured. Project developers must transparently justify the selected boundaries in the Project Overview Document (POD), considering factors such as material traceability, data availability, waste type, and end-use context.

If multiple scenarios (e.g., different material types, recovery methods, or product applications) are included in the same project, the spatial boundaries must be defined clearly for each scenario. Emissions must be calculated separately to ensure consistency and accuracy. Finally, the spatial boundaries must be set to include all potential sources of leakage, and should consider local or regional regulatory requirements or environmental constraints.

2.4 Temporal boundaries

The temporal boundaries define the time period during which emissions are monitored, quantified, and reported. These boundaries must align with the project's operational cycle and the timing of material recovery, processing, and substitution.

The **recommended monitoring period is one year,** but this may vary depending on the type of waste, the recovery process, and the nature of the final product. Regardless of the reporting cycle, emission reductions must be calculated over the full life cycle of the recovered product compared to its conventional counterpart.

The methodology focuses on the recovered material or component, not the entire product in which it is embedded. However, the life cycle stages that must be accounted for include:

- **Raw material stage**: Extraction and processing of virgin inputs (baseline) vs. collection and preparation of waste (project).
- **Manufacturing stage**: Conventional production process vs. the upcycling or recycling process.
- **Usage stage**: Performance and service life of the recovered and baseline product.
- **End-of-life stage**: Disposal or further recovery of the product or material.

When direct monitoring of the usage or end-of-life stage is not feasible, project developers must apply standardized assumptions based on credible sources, including:

- Product Carbon Footprint (PCF) or Life Cycle Assessment (LCA) reports,
- Peer-reviewed studies,
- Regulatory frameworks,
- Industry benchmarks or best practices

If the recovered product differs from the baseline in **durability, performance, or functionality**, the emission reduction calculation must be adjusted accordingly. For example, if the recovered product has a shorter lifespan, the model must reflect the need for more frequent replacements (see section 4.1.2 Reference Service Life).

Project developers must transparently document all assumptions and data sources used to define the temporal boundary and model life cycle impacts, and must ensure consistency with the project's stated scope and functional unit.

3 Baseline scenario

The baseline scenario represents the emissions that would occur based on the business as usual waste management practices. In other words, this includes the fate of the waste, **without the introduction of the waste recovery process**.

The project developer must establish the baseline based on the following approach:

- The baseline scenario represents the **counterfactual** emissions pathway, or in other words what would have happened to the waste in the absence of the project's waste recovery intervention. It reflects the business-as-usual (BAU) practices in the region, including typical end-of-life (EOL) treatment methods such as landfilling, incineration, or unmanaged dumping. This approach ensures that the project only claims emission reductions that are additional to what would have occurred without it.
- The baseline must be defined based on the types and quantities of waste recovered and their likely fates under BAU conditions. These fates must be supported by historical information, regional practices, market evidence, financial drivers or waste management statistics.
- For projects that replace virgin materials with waste-derived alternatives (e.g. Product A in *Figure 2),* the baseline includes the full linear supply chain of that product: raw material extraction, manufacturing, usage, and end-of-life. If the project also involves the diversion of waste from other sectors (e.g. Product B), then the baseline includes the average treatment or disposal of that waste stream. In single-stream projects, only Product A's chain is considered. In multi-stream projects, each relevant linear chain (A, B, etc.) is assessed individually.
- Emission sources that are identical between the baseline and project scenario, such as the usage phase, if unchanged, may be excluded from quantification.

Where multiple options or data sources are available, conservative estimates must be used, to avoid overestimating the impact of the project interventions [7].

[7] Specifically, the project developer must select the emission factors, volumes and any other relevant data so that the total baseline emissions are not overestimated and the total project emissions are not underestimated.

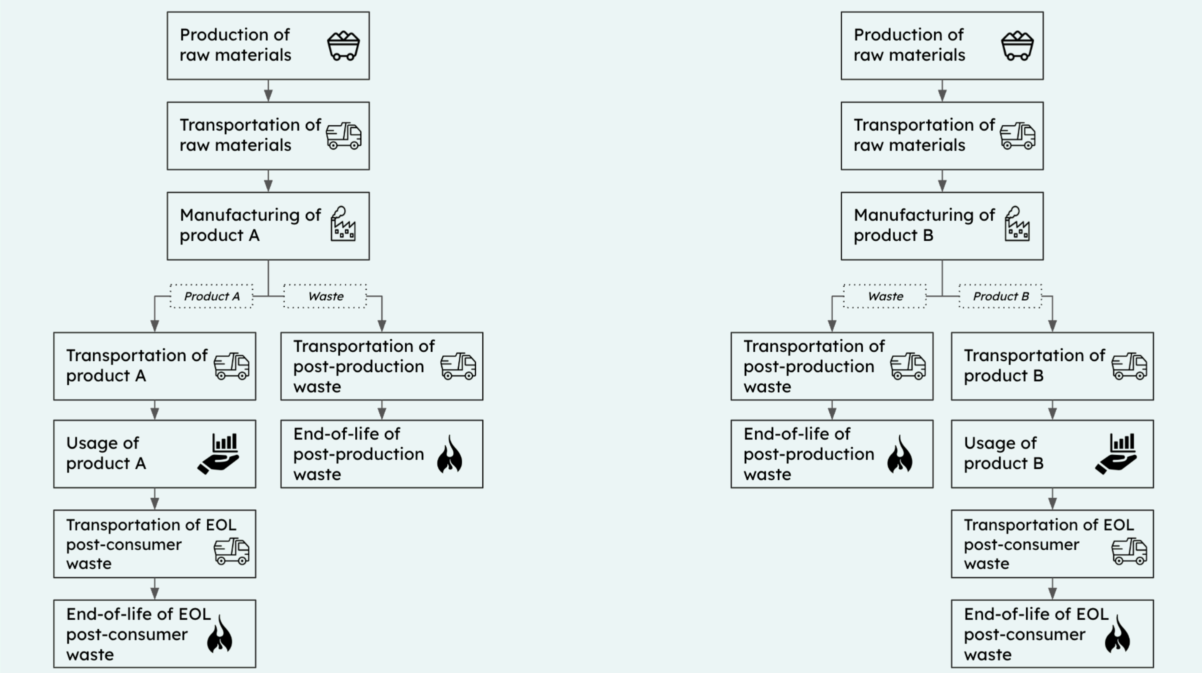

Figure 2: Baseline visualization. Different baseline routes that must be accounted for, depending on the source of the waste.

4 Calculation of GHG emissions

The project developer must calculate the **total GHG emissions** for both the baseline and project scenario. These emissions must be transformed into tonnes of CO_2e for each verification period (see Appendix B: CO_2e and Global Warming Potential).

4.1 Functional equivalence and comparative basis

The calculation of GHG emissions must be based on a transparent and credible comparison between the baseline and project scenarios. In this methodology, the baseline product refers to the conventional product that would have been used in the absence of the project, while the project product refers to the material or component produced through waste recovery. Emission calculations must reflect differences in product function, quantity required, lifecycle duration, and end-of-life treatment. In cases where the recovered product is a direct substitute for the baseline product, a 1:1 replacement ratio may apply. However, if the recovered product differs in performance or lifespan, adjustments are required to maintain a consistent and credible basis for comparison.

The following elements must be explicitly addressed in the Project Overview Document (POD) and incorporated into the emission calculations for the baseline, project, and resulting emission reductions.

4.1.1 Functional performance

- Project developers must first establish that the recovered product meets the same functional requirements as the baseline product. Functional performance refers to the specific service or outcome the product is designed to deliver. This will vary depending on the product category. For example, thermal insulation materials must meet defined thermal resistance values, while structural components must support comparable mechanical loads.
- The POD must define the functional requirements relevant to the baseline product and provide evidence that the recovered product satisfies these same criteria. This may include technical specifications, material property data, laboratory test results, or third-party certifications.

4.1.2 Reference Service life

- The expected service life of the recovered product must be considered in relation to that of the baseline product. This includes the Reference Service Life (RSL), defined as the period during which the product performs its intended function under standard use conditions without significant deterioration or maintenance.

- If the RSL of the recovered product differs from that of the baseline product, this difference must be reflected in the emission calculations. For example, if the recovered product lasts half as long, the emissions from producing and disposing of two units must be included to maintain comparability with a single unit of the baseline product.
- Evidence supporting the claimed service life must be provided in the POD. This may include manufacturer data, peer-reviewed studies, field trials, or established LCA parameters.

4.1.3 Substitution ratio

- In cases where the recovered product does not replace the baseline product on a 1:1 basis, the substitution ratio must be adjusted to reflect actual usage or material input. This may be necessary when the recovered product differs in mass, density, coverage area, or functional yield.
- Project developers must clearly justify the substitution ratio used and demonstrate that it reflects realistic performance in the intended application. Any assumptions made must be documented and supported by data or relevant industry benchmarks.

4.1.4 End-of-life differences

- Where the recovered product differs from the baseline product in terms of end-of-life treatment, such differences must be reflected in the GHG accounting. This includes variations in disposal method, recyclability, decomposition emissions, or potential for reuse.
- If the recovered product has a more favourable or less favourable end-of-life profile than the baseline, these impacts must be quantified and included in both scenarios to ensure consistency. When direct monitoring is not feasible, reasonable and documented assumptions must be applied based on LCA literature, PCF reports, or regulatory guidance.

4.2 GHG emissions

This section outlines how to calculate the GHG emissions associated with both the baseline and project scenarios. Emissions must be quantified for each relevant activity affected by the intervention, using consistent functional units and boundaries. The following subsections describe the specific sources of emissions to be included and the required methods for calculation.

When calculating recovery emissions, project developers may use one of the following approaches:

- Primary (Tier 3) data which are project specific (e.g., energy use, fuel consumption, process emissions)
- Secondary (Tier 1-2) data (e.g., literature values, LCA databases, industry benchmarks) when primary data are not available

Where feasible, material-specific emission factors should be used to reflect the differences in recovery intensity for various materials (e.g., plastics vs. metals vs. composites). These factors may be expressed per tonne of input or per tonne of recovered output, but consistency must be maintained.

4.2.1 Production of raw materials (baseline only)

Emissions must be calculated based on the type and quantity of raw material that would have been used in the absence of the project, using material-specific cradle-to-gate emission factors. These factors should reflect regional or product-specific characteristics where available, or use conservative default values from recognized LCA databases. These emissions are calculated based on the following equation:

$$E_1 = \sum_r (EF_r \cdot Q_r) \tag{1}$$

Where:

E_1	=	Total GHG emissions from production of virgin raw materials (tCO_2e/year)
EF_r	=	Emission factor for the production of raw material r (tCO_2e/tonne)
Q_r	=	Quantity of raw material r that would be used in the baseline (t/year)

Only the fraction of recovered material that demonstrably replaces virgin input can be credited. If functional equivalence is partial, the emission reductions must be adjusted accordingly, as described in section 4.1 Functional equivalence and comparative basis.

4.2.2 Transportation of (raw and/or waste) materials

The emissions are calculated for each material (x) in scope.

- For the raw materials the calculation is based on the distance between their production location and the manufacturing of the corresponding product, and the mode of transportation used (m).
- For the waste materials the calculation is based on the distance between their usage location and their EOL location, and the mode of transportation used (m).

$$E_2 = \sum_c \sum_x (EF_m \cdot Q_{x,c,m} \cdot D_{x,c,m}) \tag{2}$$

Where:

E_2	=	Total GHG emissions of transportation (tCO_2e/year)
EF_m	=	Emission factor of the mode of transportation m (tCO_2e/tonne-km)
$Q_{x,c,m}$	=	Quantity of material x sent to location c via the mode of transportation m (t/year)
$D_{x,c,m}$	=	Distance traveled of material x to location c via the mode of transportation m (km). If the specific location is not known, a conservative average distance can be assumed, provided that it is thoroughly justified in the POD.

4.2.3 Waste recovery process (baseline and/or project)

The waste recovery process refers to the activities required to transform waste materials into a usable product or feedstock, including sorting, cleaning, mechanical or chemical processing, and any other steps necessary to meet the performance and quality criteria of the recovered material.

Emissions from the project-side recovery process must always be accounted for. These represent new activities introduced by the intervention and are a direct source of project emissions.

In contrast, baseline recovery emissions are only relevant when the waste stream was already being diverted to a recovery or recycling pathway before the project. In such cases, the baseline must reflect the emissions from the existing process that is being displaced. If a functioning baseline recovery route exists, a leakage assessment is required, as described in section 1.8 Leakage & permanence. The project intervention must demonstrate that it results in a net reduction in GHG emissions compared to the displaced recovery pathway.

To calculate the waste recovery emissions, the following equation can be used for each material or waste stream:

$$E_3 = \sum_x (EF_{x,rec} \cdot Q_{x,rec}) \tag{3}$$

Where:

E_3	=	Emissions of the waste recovery process (tCO_2e/year)
$EF_{x,rec}$	=	Emission factor for recovering material x (tCO_2e/tonne)
$Q_{x,rec}$	=	Quantity of waste material x processed through the recovery operation (t/year)

If the emission factor used covers the entire mass of processed waste, no further conversion is needed. If it only applies to the recovered fraction (e.g., recycled output), the emission must be scaled accordingly using the recovery yield.

4.2.4 Manufacturing of final product (if affected)

This component accounts for any change in GHG emissions during the manufacturing of the final product resulting from the use of recovered materials. It is only included if the use of the recovered input leads to a measurable change in energy use, process emissions, or other manufacturing-related impacts compared to the baseline material. If there is no significant difference, this component can be excluded, but the assumption must be justified in the Project Overview Document (POD). These emissions are calculated based on the following equation:

$$E_4 = \sum_{mp} (EF_{mp} \cdot Q_x) \tag{4}$$

Where:

E_4	=	Total GHG emissions from the manufacturing stage (tCO_2e/year)
$EF_{x,m}$	=	Emission factor for manufacturing with material x (tCO_2e/tonne)
Q_x	=	Quantity of product manufactured using material x (t/year)

The emission factors selected should reflect differences in processing requirements between virgin and recovered inputs.

4.2.5 End-of-life treatment of waste

This component accounts for the GHG emissions that would occur from the disposal of the waste materials in the absence of the project. It also includes the EOL emissions from the recovered product.

Project developers must assess the likely end-of-life (EOL) pathways for each relevant waste stream. This includes identifying the share of waste going to landfill, incineration (with or without energy recovery), recycling, or other treatment. Disposal ratios must be based on reliable sources such as industry reports, national statistics, LCA studies, or documented company practices.

Once the EOL mix is established, the GHG emissions must be calculated as the sum of emissions from all relevant waste fates, weighted according to the proportion of waste allocated to each fate. For each pathway, the relevant emission factors or estimation methods should be applied. The IPCC Guidelines for National GHG Inventories – Volume 5: Waste (Category 5) may be used to calculate emissions from landfill, incineration, and wastewater handling. Project developers are responsible for selecting the appropriate calculation method for each relevant EOL pathway based on the waste type and disposal practice.

Below are indicative approaches for common disposal scenarios:

Incineration without energy recovery (fossil-based content)

Estimate CO_2 emissions from the fossil carbon content of the waste.

$$E_{inc} = Q_{x,inc} \cdot C_x \cdot F_{fossil} \cdot 44/12 \tag{5}$$

Where:

$Q_{x,inc}$	=	Quantity of waste x incinerated (t/year)
C_x	=	Carbon content (tonnes C / tonne waste)
F_{fossil}	=	Fossil share of total carbon
$44/12$	=	Molecular weight ratio for CO_2 from C

Incineration with energy recovery

Subtract avoided fossil fuel emissions from the incineration emissions.

$$E_{net,\,inc} = E_{net,\,inc} - ER_{heat} - ER_{elec} \tag{6}$$

Where:

ER_{heat}	=	Avoided emissions from displaced thermal energy $E_{heat} = Q_{x,inc} \cdot CV_x \cdot EF_{fuel}$
ER_{elec}	=	Avoided emissions from displaced electricity $ER_{elec} = ER_{heat} \cdot EE$
CV_x	=	Calorific value of waste x (MJ/tonne)
$EF\ (fuel)$	=	Emission factor of displaced fossil fuel ($kgCO_2e$/MJ)
EE	=	Energy conversion efficiency to electricity (%)

Other (e.g., open burning, uncontrolled dumping, recycling, etc)

Use simplified IPCC default factors or regional LCA data.

$$E_{other} = Q_{x,other} \cdot EF_{x,other} \tag{7}$$

Where:

$EF_{x,other}$	=	Default emission factor for activity (tCO_2e/tonne)

4.3 Uncertainty

To ensure the credibility and conservativeness of emission reduction estimates, this methodology provides two approaches for addressing uncertainty, depending on the type of project and the tier of data used (see Appendix A: Data selection).

Option 1: Projects with Tier 3 Data

For projects using Tier 3 data, the project developer must conduct a quantitative uncertainty assessment. To do that the tool developed by the GHG Protocol Initiative [8] can be used. This Excel-based tool automates the aggregation steps for developing a basic uncertainty assessment for GHG inventory data, following the Intergovernmental Panel on Climate Change (IPCC) Guidelines for National GHG Inventories. The tool is supplemented by a guidance document [9], which describes the functionality of the tool and gives a better understanding of how to prepare, interpret, and utilize uncertainty assessments. This approach allows for more precise project-specific estimates and may support higher claims when uncertainty is well-characterized and transparently reported.

[8] https://ghgprotocol.org/calculation-tools-and-guidance
[9] https://ghgprotocol.org/sites/default/files/2023-03/ghg-uncertainty.pdf

Option 2: Projects with Tier 1 or Tier 2 Data

Projects using Tier 1 or Tier 2 data, a simplified, conservative approach must be followed to ensure robustness of estimates:

- **Conservative Parameter Selection**: Project developers must select values from the conservative end of available ranges. While not necessarily the lowest value, selections should lean towards the lower half of the range to avoid overestimating reductions.
- **Meta-Analysis Based Factors**: When using meta-analyses to derive emission factors or emission reduction percentages, developers should combine multiple context-specific variables to ensure the selected EF (from the EF ranges) is both conservative and grounded in the most relevant evidence.

This approach provides a practical and reliable framework for uncertainty management in cases where project-specific measurements are not feasible.

5 Net reduction of GHG emissions

The project developer can *estimate* the GHG emissions reduction of the project during the crediting period based on the best available data at the time of the validation of the POD. The issuance of the emission reduction certificates is done on a yearly basis, after updating the project design parameters (see section 6.1 Monitoring), and verifying the GHG emission reduction by a VVB. In other words, the *project emissions* and therefore the *net reduction of GHG emissions* are *dynamic* as they can change from year to year, depending on the actual project details.

The GHG emission reduction is defined as the difference between the baseline emissions and the project emissions.

To conservatively account for potential leakage, a (potentially reversible) leakage deduction factor is applied to the total net emission reductions. This factor reflects the assessed risk that the project activity may indirectly cause an increase in GHG emissions outside the project boundary, through market displacement. The applicable leakage deduction is determined based on the classification described in section 1.8 Leakage & permanence.

To calculate the net GHG emissions reduction, the following equation can be used:

$$ER = BE - PE - LE \tag{8}$$

Where:

ER	=	Net GHG emissions reduction (tCO_2e)
BE	=	Baseline emissions (tCO_2e)
PE	=	Project emissions (tCO_2e)
LE	=	Leakage emissions (tCO_2e)

6 Monitoring, reporting, and verification (MRV)

The MRV process is a structured approach to quantifying, tracking, reporting, and verifying greenhouse gas (GHG) emissions and reductions achieved through the recovery of waste products. The goal of the MRV approach is to ensure accurate, consistent, and credible measurement and reporting of emissions over time, enabling the issuance of high-quality environmental attributes.

The monitoring plan includes:

- The type of information that needs to be collected
- The proof for each datapoint
- The frequency of reporting

6.1 Monitoring

For this methodology, the monitoring focuses on collecting three key types of data:

A. **Project Scoping**: Key project details defined before the project start, submitted once during the POD validation phase.

B. **Project Design Parameters**: Variables monitored and reported during each verification cycle to ensure compliance and accuracy. Those must be completed for each specific intervention that is outlined in the project scoping.

C. **Project Impact**: Outcomes calculated during each verification cycle, based on the monitored project design parameters. Again, the impact must be calculated and presented separately for each intervention in scope.

Table 4: Project scoping

Index	*Name*	*Description*	*Background from this methodology*	*Proof required*	*Frequency of reporting*
A1	Scope of activities	Present list of interventions that are in scope of the project	Section 2.1	N/A	Once during POD validation or update during verification if they change during the crediting period
A2	GHG sources	Explain which GHG sources are in scope of the intervention	Section 2.2	N/A	
A3	Spatial boundary and size	Present lists of facilities and locations where interventions make changes from the baseline scenario.	Section 2.3	N/A	
A4	Temporal boundary (for monitoring)	Present lists of all relevant lifecycle stages	Section 2.4	N/A	
A5	Additionality	Prove the additionality requirements	Section 1.4	See section	

Table 5: Project design parameters

Index	*Category name*	*Subcategory name*	*Description*	*Proof required for baseline*	*Proof required for project*	*Frequency of reporting*
B1.1	4.1 Functional equivalence and comparative basis	-	• If the recovered product has different durability, efficiency, or functional performance that alters use-phase emissions (e.g. energy consumption, maintenance frequency).	• Industry references on typical service life/maintenance of virgin products • Any baseline data on energy usage in operation. • Specific information retrieved from PCF/LCA reports • Use of scientifically based scenarios if direct measurement is not practical	• Field data or test reports on recovered product performance (e.g. expected lifetime, energy draw). • Repair/maintenance records showing whether performance differs significantly • Use of scientifically based scenarios if direct measurement is not practical • Standardized quality assurance testing results and warranty	Reconfirmed or updated for every verification
B2.1	4.2.1 Production of raw materials (baseline only)	-	• Mass/volume and type of virgin materials that would have been used without the recovery intervention. • Associated upstream impacts (e.g., mining, drilling, or other extraction processes).	• Industry/historical data on typical virgin feedstock consumption in the region. • Published LCAs or EF (emission factor) databases (IPCC, GHG Protocol)	• Mass-balance documents proving how much virgin feedstock is actually replaced by the recovered material. • Any supporting data if partial virgin inputs are still used.	
B2.2	4.2.2 Transportation of (raw and/or waste) materials	Distribution Routes	• Distances/modes to deliver each material. • EF by vehicle type (truck, ship, rail), based on the region's energy mix.	• Typical route distances in baseline (mines/ports → factory → end user) • Average emission factors (IPCC, GHG Protocol, local guidelines) • Specific information retrieved from PCF/LCA reports	• Shipping/transport logs/routes for recovered products (f.i. based on fuel receipts, GPS, or third-party confirmations) • Updated or region-specific EFs if the project invests in more efficient transport	

Index	*Category name*	*Subcategory name*	*Description*	*Proof required for baseline*	*Proof required for project*	*Frequency of reporting*
B2.3	4.2.3 Waste recovery process (baseline and/or project)	Waste Type & Quantity	• Identify each waste stream. • Measure total mass/volume diverted. • Initial condition or key performance metrics of the waste/product at collection	• Historic disposal records or stats. • Landfill/incineration logs. • Specific information retrieved from PCF/LCA reports	• Weighbridge tickets, invoices, or audits of actual waste collected/diverted	
		Sorting Efficiency	• Fraction of recovered material vs. residue. • Sorting method (manual/mechanical/other)	• Assumption of minimal/no sorting in baseline • Any partial recovery data if recovery happens before. • Specific information retrieved from PCF/LCA reports	• Facility logs for recovered vs. rejected mass • Process flow diagrams	
		Recovery Energy & Inputs	• Electricity/fuel for shredding, washing, etc. • Any pre-treatment additives. • Emission factors for electricity and fuel used	• Industry/average data for virgin extraction • Default energy consumption. • Specific information retrieved from PCF/LCA reports • Regional grid-mix EF	• Meter readings, fuel bills for actual recovery steps • Equipment specs • Regional grid-mix EF	
B2.4	4.2.4 Manufacturing of final product (if affected)	Material Composition	• Ratio of virgin vs. recovered feedstock. • Any additives or binders required	• Conventional "recipe" or bill of materials for virgin products. • Specific information retrieved from PCF/LCA reports	• Purchase orders or batch sheets detailing recovered vs. virgin inputs • Mass balance documentation	

Index	*Category name*	*Subcategory name*	*Description*	*Proof required for baseline*	*Proof required for project*	*Frequency of reporting*
		Manufacturing Energy	• Electricity/fuel used to process materials (e.g., melting, forming) • Emission factors for electricity and fuel used	• Published LCAs or site-specific energy records for baseline • Specific information retrieved from PCF/LCA reports • Regional grid-mix EF	• Meter or sub-meter data for recovered line • Utility bills/production logs isolating recovered processes • Regional grid-mix EF	
		Yield & Quality	• Final product yield, rejects/rework rates • QA tests, certifications ensuring functional equivalence	• Historical yield data for virgin products (e.g., scrap rates) • QA/QC reports proving performance standards are met • Specific information retrieved from PCF/LCA reports	• Logs showing recovered-content yield vs. rejects • QA/QC reports proving performance standards are met	
B2.5	[4.2.5 End-of-life treatment of waste]()	Residue Disposal	• Disposal: EF for various disposal scenarios • How non-recoverable residues or by-products are handled (landfill, incineration, etc.)	• Local disposal regulations. • Historical disposal logs • Regional electricity mix (for fossil fuel substitution by incineration) • Specific information retrieved from PCF/LCA reports	• Disposal facility receipts, weighbridge tickets • Proof of compliant disposal for non-recoverable residues	
B2.6	[1.8 Leakage & permanence]()	-	Document the evidence that supports the leakage-risk tier (Low 0 %, Medium 5 %, High 10 %)	• Prior fate of waste (e.g., disposal statistics, recycling rates) • Regional supply-demand balance for the waste stream • Historic secondary-market price trends	• Actual sourcing records showing where waste was collected • Market analysis demonstrating no displacement of existing recovery • Third-party confirmations or trade data	At POD submission, then every verification **if anything changes** (minimum once every 4 years)

Table 6: Project impact

Index	*Category name*	*Subcategory name*	*Calculation method*	*Frequency of reporting*
C1	Net reduction of GHG emissions	-	Section 5	Updated every verification

6.2 Reporting

Monitoring reports must include:

- A general description of the project, including the locations where baseline emissions would occur and the project waste recovery is done.
- A description of the data collection process, frequency of monitoring, and procedures for archiving data, as presented in section 6.1 Monitoring
- The roles of individuals involved in monitoring and data collection (e.g., responsibilities)
- The monitoring time period must be documented in every report.
- The frequency of the submission of the monitoring reports is defined based on the direction given in section 2.4 Temporal Boundaries
- All monitoring reports must be accessible on the demand of the *Validation, Verification Bodies* (VVB) for validation and verification procedures.

6.3 Verification

An accredited Validation and Verification Body (VVB) must be selected to execute the verification process based on the monitoring plan and reports to confirm that the program's requirements are met, ensuring the accuracy of the calculated GHG reductions resulting from the waste recovery.

References

IPCC Guidelines

- Intergovernmental Panel on Climate Change (IPCC). *2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 5: Waste.* Available at: https://www.ipcc-nggip.iges.or.jp/public/2006gl/vol5.html
- Intergovernmental Panel on Climate Change (IPCC). *2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories.* Available at: https://www.ipcc-nggip.iges.or.jp/public/2019rf/index.html

GHG Protocol

- GHG Protocol. *Technical Guidance for Calculating Scope 3 Emissions: Category 5 – Waste Generated in Operations.* World Resources Institute (WRI) and World Business Council for Sustainable Development (WBCSD). Available at: https://ghgprotocol.org/scope-3-technical-guidance

Product Carbon Footprint (PCF) and Life Cycle Assessment (LCA)

- ISO 14040:2006. *Environmental management – Life cycle assessment – Principles and framework.* International Organization for Standardization (ISO).
- European Commission – Joint Research Centre. *ILCD Handbook Series: International Reference Life Cycle Data System (ILCD).* Available at: https://eplca.jrc.ec.europa.eu/ILCDHandbook.html
- European Commission. *Recommendation on the use of the Environmental Footprint methods to measure and communicate the life cycle environmental performance of products and organisations.* (PEF Method). Official Journal of the European Union, 2021/C 227/01. Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32021H2279
- GHG Protocol. *Estimating and Reporting the Comparative Emissions Impacts of Products: Guidelines for Attributional and Consequential LCA Approaches.* Available at: https://ghgprotocol.org/product-guidance

Sector-Specific LCA Example

- Japan Automobile Tyre Manufacturers Association (JATMA). *Tyre LCCO$_2$ Calculation Guidelines Ver. 3.0.1 (Full Disclosure Version).* See especially page 3 for LCA structure and data principles.

Appendix A: Data selection

In the context of greenhouse gas (GHG) emissions reporting and inventory management, data and methodologies are categorized into three tiers (Tier 1, Tier 2, and Tier 3), as defined by the Intergovernmental Panel on Climate Change (IPCC). These tiers represent varying levels of accuracy, data specificity, and complexity. Here's a detailed look at each:

Table 7: Tier 1, 2 and 3 explanation

Tier 1	Tier 2	Tier 3
This is the most basic level of calculation which uses default emission factors provided by the IPCC or other authoritative sources. These factors are generally based on a **broad average of data** and are meant for use when more specific data are not available. It is ideal for initial assessments, small-scale projects, or regions where data collection capabilities are limited. It requires the least amount of data and provides estimates that are less precise.	These methodologies are more accurate than Tier 1 and involve **country-specific or region-specific** emission factors. These factors take into account the specific characteristics of fuels or technology used in a particular geographic area. They are used when more detailed, reliable data are available and a greater degree of accuracy is required.	This is the most sophisticated level that uses highly **detailed data and advanced statistical or modeling techniques**. This tier often involves continuous emission measurements and may incorporate real-time data collection. It is appropriate for detailed monitoring and reporting, often used in large industries or for regulatory compliance where precise data tracking is necessary.

When evaluating data sources, the project developer must prioritize them in the following order: Tier 3, Tier 2, and Tier 1. This hierarchy ensures that the most robust and reliable data is used first, minimizing potential uncertainty. More information on the impact of data quality on the Uncertainty Factor can be found in section 5 Net GHG emissions reductions.

Tier 3 sources, as defined by the IPCC, offer the highest level of accuracy and detail, making them the most reliable for greenhouse gas (GHG) emissions reporting and inventory management. Tier 2 sources provide moderate accuracy and detail, serving as a secondary option when Tier 3 data is not available. Tier 1 sources are the least detailed and accurate, used only when higher-tier data cannot be accessed. This prioritization ensures the most precise and credible data for effective GHG emissions management.

Overall, baseline emissions must not be overestimated and project emissions underestimated, to guarantee true impact. When in doubt and if no Tier 3 values are available, lower values should be used for baseline emissions (best in class), and higher values should be used for project emissions.

If available, the Project Developer should use a 3-year average of the available data. When a range of relevant data is available (quantities or emission factors) the most **conservative** should be selected, so that the GHG yield is not overestimated.

Appendix B: CO_2e and Global Warming Potential

CO_2e is a metric used to compare the emissions of various greenhouse gases based on their Global Warming Potential (see GWP definition). It expresses the impact of different gases in terms of the equivalent amount of CO2, facilitating a standardized approach to assessing overall greenhouse gas emissions.

The table below lists the GWP of three key greenhouse gases relative to CO_2:

Table 8: Carbon dioxide equivalents per GHG [10]

Greenhouse Gas	Chemical Formula	Global Warming Potential (GWP)
Carbon Dioxide	CO_2	1
Methane (n-f)	CH_4	29.8
Nitrous Oxide	N_2O	273

As such, the equation for calculating the emissions of a GHG expressed in CO_2e is the following:

$$E_{CO_2e} = E_{GHG} \cdot GWP \tag{9}$$

Where:

E_{CO_2e}	=	Emissions of GHG expressed in CO_2e (t CO_2e/year)
E_{GHG}	=	Emissions of GHG (t GHG/year)
GWP	=	Global warming potential of GHG (t CO_2e/t of GHG)

[10] https://ghgprotocol.org/sites/default/files/2024-08/Global-Warming-Potential-Values%20%28August%202024%29.pdf