Plastic Waste Reduction Program Methodology

PWRM0002

PLASTIC WASTE ~~MECHANICAL~~ RECYCLING METHODOLOGY

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This methodology was developed by:

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1 SOURCES

This methodology references certain definitions, criteria and procedures set out in the following methodologies and tools:

- Clean Development Mechanism (2018). *AMS-III.AJ. Small-scale methodology: Recovery and recycling of materials from solid wastes, version 07.0*
- Clean Development Mechanism (2018). *AMS-III.BA. Small-scale methodology: Recovery and recycling of materials from e-waste, version 02.0*
- Clean Development Mechanism (2007). *AMS-III.L. Avoidance of methane production from biomass decay through controlled pyrolysis, version 02.0*
- Clean Development Mechanism (2019). *CDM-EB50-A30-STAN. Standard: Sampling and surveys for CDM project activities and programmes of activities, version 08.0*
- Clean Development Mechanism (2015). *CDM-EB67-A06-GUID. Guideline: Sampling and surveys for CDM project activities and programmes of activities, version 04.0*
- Clean Development Mechanism (2012). *Methodological tool 01: Tool for the demonstration and assessment of additionality, version 07.0.0*
- Clean Development Mechanism (2017). *Methodological tool 02: Combined tool to identify the baseline scenario and demonstrate additionality, version 07.0*
- Clean Development Mechanism (2019). *Methodological tool 21: Demonstration of additionality of small-scale project activities, version 13.0*
- Clean Development Mechanism (2019). *Methodological tool 27: Investment analysis, version 10.0*
- EUCertPlast Technical Committee (2019). *EUCertPlast Audit Scheme, version 4.0*

The following have also informed the development of this methodology:

- IPCC (2019). Solid waste disposal. In: *Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Vol. 5*
- *ISO 14040:2006 Environmental management – Life cycle assessment – Principles and framework*
- *ISO 14064-2:2006 Greenhouse gases – Part 2: Specification with guidance at the project level for quantification, monitoring and reporting of greenhouse gas emission reductions or removal enhancements* (clause 4)

- *ISO 15270:2008 Plastics – Guidelines for the recovery and recycling of plastics waste*
- Textile Exchange (2019). *TE-101-V1.0-2019.10.01 – Terms and definitions for Textile Exchange standards and related documents*

2 SUMMARY DESCRIPTION OF THE METHODOLOGY

Additionality and crediting methods	
Additionality	Activity and project methods
Crediting baseline	Project method

This methodology provides procedures to estimate the additional plastic waste[1] recycled through chemical and/or mechanical recycling activities,[2] including the installation of new recycling facilities, capacity additions to or technology improvement of existing recycling facilities, and incentivizing or facilitating an increase in recycling through the collection and/or sorting of plastic waste.

Recycling activities may include collection, sorting and/or ~~mechanical~~ recycling (i.e., production of recycled material) of plastic waste that otherwise would have been managed in a way that would not allow for a second life of the material.

Projects that result in both collection and ~~mechanical~~ recycling of plastic waste ~~shall~~must apply this methodology in conjunction with an approved plastic waste collection methodology to demonstrate additionality and quantify the plastic waste collected and recycled by the respective activities.

Sections that are not applicable to projects using the *Plastic Waste Reduction Standard* (*Plastic Standard*) only to account for the results of their recycling activities and not to issue Waste Recycling Credits (WRCs) are marked as such.[3]

[1] In this document, the term plastic waste refers to all waste that includes materials under the scope of the Plastic Waste Reduction Program (Plastic Program), including composite materials (e.g., used beverage cartons).
[2] In this document, chemical and mechanical recycling are together referred to as recycling, unless otherwise specified.
[3] In this *Plastic Waste ~~Mechanical~~ Recycling Methodology, v1.~~0~~1*, this is Section 7.

3 DEFINITIONS

In addition to those set out in the *Plastic Waste Reduction Program Definitions*~~,~~ (*Plastic Program Definitions*), the following definitions apply to this methodology:

Capacity addition
An increase in the capacity of an existing recycling facility through the addition of new equipment, replacement or modification of existing equipment and/or modification of the recycling process

Collected material
Plastics material that has been removed from the environment or recovered, separated, diverted or removed from the solid waste stream in order to ensure suitable end of life, such as recycling, landfill or incineration with energy recovery (adapted from *ISO 15270:2008 Plastics – Guidelines for the recovery and recycling of plastics waste*). This can include post-consumer and post-industrial material.

Collection area
The geographic area from which plastic waste is collected (e.g., households, businesses). Where plastic waste is collected from a concentrated source (e.g., landfill, waste aggregation center, sorting center), or from geographic areas outside the project boundary (excluding imported plastic waste), the collection area should include both the source and the surrounding geographic areas from where the waste originated.

Contaminant
Unwanted substance or material. Contaminants may include, but are not limited to, liquids, organic matter, and other plastic types and materials. A contaminant may or may not be hazardous.

Depolymerization
The process of converting larger macromolecules (e.g., plastic polymers) into smaller molecules such as component monomers[4]

Energy recovery
The production of useful energy through direct and controlled combustion (*ISO 15270:2008 Plastics – Guidelines for the recovery and recycling of plastics waste*)

Extended producer responsibility (EPR) [5]
A policy approach under which producers are given a significant financial and/or physical responsibility for the treatment or disposal of post-consumer products

[4] Adapted from Chapter 4 – Coalification, gasification and gas storage, pp. 167-233 in Flores, R.M. (2014). *Coal and Coalbed Gas: Fueling the Future*. Elsevier Inc. Available at: https://doi.org/10.1016/B978-0-12-396972-9.00004-5.
[5] Organisation for Economic Co-operation and Development (n.d.). *Extended Producer Responsibility.* Available at: https://www.oecd.org/env/tools-evaluation/extendedproducerresponsibility.htm.

Fillers
Particles or materials that are mixed with plastic polymers to change their properties (e.g., morphological, mechanical, thermal, electrical properties) and/or to decrease the cost of production. Fillers may be, among others, minerals (e.g., calcium carbonate, talc, ceramics, liquids or bio-based materials (e.g., coir fiber).[6]

Gasification
A thermo-chemical decomposition process at a high temperature (500–1300 °C), whereby partial oxidation leads to the depolymerization of plastic waste along with the production of synthesis gas (syngas)[7]

Hazardous
Physical, chemical, biological, reactive, toxic, flammable, explosive or corrosive characteristics of a material that can cause danger to the environment or to health, whether alone or in contact with other substances[8]

Input
Product, material or energy flow that enters a unit process (*ISO 14040:2006 Environmental management – Life cycle assessment – Principles and framework*)

Monomer
A chemical compound (e.g., ethylene, propylene, styrene), usually of low molecular mass, that can be converted into a polymer by combining it with identical monomers or with other chemical compounds (*ISO 472:2013 Plastics — Vocabulary*)

New activity
Initiation of a new recycling activity at a site where this recycling activity did not exist prior to project implementation

Oligomer
A substance (e.g., epoxy acrylate, polyester acrylate) composed of molecules containing only a few groups of atoms repetitively linked to each other (*ISO 472:2013 Plastics — Vocabulary*). The finite number of repeating units is formed during a polymerization reaction between monomers.[9]

[6] DeArmitt, C. (2011). Functional fillers for plastics. In: Kutz, M. (Ed.). *Applied Plastics Engineering Handbook* (pp. 455-468). Elsevier Inc. Available at: https://doi.org/10.1016/b978-1-4377-3514-7.10026-1 and Chapter 4 – Modifying specific properties: Mechanical properties – Fillers, pp. 19-35 in Murphy, J. (2001). *Additives for Plastics Handbook Second Ed*. Available at: https://doi.org/10.1016/b978-185617370-4/50006-3.
[7] National Energy Technology Laboratory (n.d.) Gasification Introduction. Available at: https://netl.doe.gov/research/Coal/energy-systems/gasification/gasifipedia/intro-to-gasification.
[8] Adapted from Ministry of Environment, Forest and Climate Change (2016). *Hazardous and Other Wastes (Management and Transboundary Movement) Rules*. Government of India. Available at: https://cpcb.nic.in/displaypdf.php?id=aHdtZC9IV01fUnVsZXNfMjAxNi5wZGY=.
[9] Koster et al. (2015). *Guidance on Best Practices on the Risk Assessment of Non-intentionally Added Substances (NIAS) in Food Contact Materials and Articles*. International Life Sciences Institute. Available at: https://ilsi.org/europe/wp-content/uploads/sites/3/2016/04/2015-NIAS_version-January-2016.pdf.

Open burning of waste[10]

Uncontrolled waste combustion practices, including dump fires, pit burning, fires on bare soil and barrel burning. Open burning is characterized by burning at low temperatures (between 250°C and 700°C) and in oxygen-deprived environments, leading to incomplete combustion of waste. It also refers to burning conducted in a manner such that combustion exhaust is not effectively controlled and combustion products are not vented through a stack or chimney. The following burning practices are included in this definition:

- Residential open burning: The indiscriminate burning by individuals of waste that is never collected or is collected and dumped away from dumpsites. This can occur just outside the home or in places where waste is illegally dumped, such as roadsides or other open public spaces. Occurs primarily due to its convenience and a lack of sufficient collection systems.
- Deliberate open burning in landfills and at open dumpsites: Waste in landfills and open dumpsites is often burned to reduce its volume when these sites are filled beyond their capacity or have an unknown, and likely insufficient, capacity due to the lack of planning involved in their establishment.
- Spontaneous open burning in landfills and at open dumpsites: Fires can occur spontaneously and unintentionally in large piles of trash within open dumpsites and landfills. These fires are likely caused by the lack of waste treatment, other than burning, that occurs in these disposal areas.

Output

Product, material or energy flow that leaves a unit process (*ISO 14040:2006 Environmental management – Life cycle assessment – Principles and framework*)

Polymer

A material (e.g., plastic) consisting of very large molecules, or macromolecules, composed of many repeating subunits, monomers and/or oligomers[11]

Process

A set of interrelated or interacting activities that transforms inputs into outputs (*ISO 14040:2006 Environmental management – Life cycle assessment – Principles and framework*)

[10] R20 Regions of Climate Action (2016). *Open Burning of Waste: A Global Health Disaster*. Available at: https://regions20.org/wp-content/uploads/2016/08/OPEN-BURNING-OF-WASTE-A-GLOBAL-HEALTH-DISASTER_R20-Research-Paper_Final_29.05.2017.pdf.

[11] Adapted from Jenkins, A.D. et al. (1996). Glossary of basic terms in polymer science. *Pure and Applied Chemistry* 68(12), 2287-2311. Available at: https://doi.org/10.1351/pac199668122287.

Pyrolysis
A thermo-chemical decomposition process occurring at a medium to high temperature in an oxygen-deficient environment that leads to the depolymerization of plastic waste along with the production of non-condensable combustible gases[12]

Recyclable
Characteristic of a product, packaging, or associated component that can be diverted from the waste stream through available processes and programs and can be collected, processed, and returned to use in the form of raw materials or products (*ISO 18604:2013 Packaging and the environment – Material recycling*). An item of packaging or a packaging component is recyclable if its successful post-consumer collection, sorting and recycling is proven to work in practice~~.[13] Recyclable here refers to mechanically recyclable.~~ and at scale.[14]

Recycled plastic waste
The output of the recycling facility[15] resulting from sorting and recycling of plastic waste, which can be used either directly or after further processing to manufacture recycled material[16] and subsequently recycled products

Recycled products
The physical goods that result from a product manufacturing process using recycled materials. ~~Note that~~The recycled products may be made from only recycled material or a combination of both recycled and virgin (including both fossil- and bio-based) material. Recycled products refer to the next-use stage of the recycled material. It may be possible to further recycle the recycled product after its intended use.

Recycling activity
An activity that is considered eligible under this methodology in accordance with Section 4. Recycling activities may include collection, sorting and/or ~~mechanical~~ recycling of plastic waste.

Region
The spatial extent that covers ~~preferably~~at least the geographic area containing the source of the plastic waste, the project activity, and the end destination of the plastic waste collected and/or recycled by the project activity; and at most covers the host country or countries in which the project activity and the end destination are located. The applicable geographic area may be an administrative unit (e.g., municipality, district, state or country), based on the availability of data.

[12] Adapted from CDM *AMS-III.L. Avoidance of methane production from biomass decay through controlled pyrolysis, version 2.0.*
~~[13] Adapted from Ellen MacArthur Foundation (2018). *New Plastics Economy Global Commitment*. Available at: https://www.newplasticseconomy.org/assets/doc/13319-Global-Commitment-Definitions.pdf.~~
[14] Adapted from Ellen MacArthur Foundation (2018). *New Plastics Economy Global Commitment*. Available at: https://www.newplasticseconomy.org/assets/doc/13319-Global-Commitment-Definitions.pdf.
[15] Recycling facility as defined in the latest version of the *Plastic Program Definitions*.
[16] Recycled material as defined in the latest version of the *Plastic Program Definitions*.

Solvolysis

A thermochemical process used for condensed polymers containing ether, ester or acid amide linkages that leads to the depolymerization of polymers and composite materials. The process uses reactants such as water and alcohol.[17]

Syngas

An abbreviation of synthesis gas. A mixture of predominantly carbon monoxide and hydrogen that is the primary product of the gasification process.[18]

4 APPLICABILITY CONDITIONS

This methodology is applicable when all of the following conditions are met:

1) Project activities result in~~ mechanically~~ recycled plastic waste through one or more of the following:

    a) Installation of a new recycling facility

    b) Capacity addition to or technology improvement of an existing recycling facility (e.g., retrofit or modification of an existing recycling facility, such as installation of new equipment or replacement of old equipment, which results in increased recycling capacity)

    c) Incentivizing and/or facilitating an increase in the collection and/or sorting of plastic waste to enable an increase in its ~~mechanical ~~recycling (e.g., paying price premiums to collectors, establishing collection or sorting points at landfills, sorting recyclable plastic waste)

    Projects that enable an increase in ~~mechanical~~the recycling of plastic waste through increased collection and/or sorting ~~activities shall apply the ~~of plastic waste must be able to provide the evidence necessary to meet the requirements of this methodology~~ as a joint project with the mechanical recycler and include the ~~. The recycling facility or facilities[19] that process the collected and/or sorted plastic waste must be included in the project boundary and the project proponent must describe the procedures or arrangements (e.g., contractual agreements) in place to eliminate double counting of recycled plastic waste potentially resulting from the project proponent and a recycling facility both claiming credits for the same recycled plastic waste.

2) The plastic waste being recycled is either collected or diverted from:

    a) The environment;

[17] Goto, M., Sasaki, M., & Hirose, T. (2006). Reactions of polymers in supercritical fluids for chemical recycling of waste plastics. *Journal of Materials Science* 41, 1509-1515. Available at: https://doi.org/10.1007/s10853-006-4615-2.
[18] Solis, M., & Silveira, S. (2020). Technologies for chemical recycling of household plastics – A technical review and TRL assessment. *Waste Management* 105, 128-138. Available at: https://doi.org/10.1016/j.wasman.2020.01.038.
[19] A project proponent collecting and/or sorting plastic waste may work with multiple recyclers to facilitate an increase in the recycling of plastic waste.

b) Landfill;

c) Open burning;

d) Incineration with energy recovery;

e) Households and/or commercial entities;

f) Incineration without energy recovery; or

g) Any other waste management option that does not allow for a second life of the plastic waste.

3) Project activities include mechanical and/or chemical recycling[20] as defined in the latest version of the *Plastic Program Definitions*.

4) The plastic waste stream is sorted[21] before it enters the recycling process. The project proponent must provide a sorting description (i.e., documentation of the sorting process implemented by the sorting facility prior to the recycling process). The sorting process must result in a plastic waste stream (homogeneous or heterogeneous) that is appropriate for the recycling technology used in the project. The sorting description must include the following:

   a) Source of the plastic waste (e.g., household, industrial entity);

   b) Technologies and methods used to sort the plastic waste;

   c) Detailed description of the sorting criteria; and

   d) Expected material composition of output waste streams post-sorting, according to material types defined in the latest version of the *Plastic Standard*.[22]

   Technologies and/or methods for sorting plastic waste include, but are not limited to, manual sorting (i.e., based on color, size or other physical features), automatic sorting techniques (e.g., near infrared, X-rays), electrostatic sorting, sink-float separation and selective dissolution. This methodology does not prescribe or limit the technology and/or method used to sort plastic waste.

   Credible evidence such as manufacturer specifications or good practice guidance (GPG)[23] must be provided to demonstrate that the technology and/or method used to sort plastic waste is appropriate for the collected plastic waste and the technology or technologies used to recycle the plastic waste.

5) Plastic waste intended for recycling is not mixed with hazardous materials or substances (e.g., coatings, adhesives or colorants) that could become unsafe if compressed, combined or exposed to

[20] Eligible chemical recycling technologies include, but are not limited to, thermal cracking, gasification, pyrolysis and solvolysis (including use of sub and/or supercritical fluids). The methodology does not prescribe or limit the eligibility of chemical recycling activities based on the recycling technology.
[21] The intent of sorting is to ensure that only relevant plastic waste enters the recycling process. It also aims to ensure increased efficiency of plastic waste recovery.
[22] Material types included in the scope of the Plastic Program are set out in the latest version of the *Plastic Standard*.
[23] Good practice guidance (GPG) here refers to recommendations for sorting of plastic waste and the logic, rationale and evidence underpinning such recommendations.

high temperatures during the recycling process. If the plastic waste contains hazardous materials or substances, it must be treated following relevant national, regional and local regulations, industry best practices and/or internationally or nationally available GPG before entering the recycling process.

~~3)~~6) It is possible to directly measure and record the final output of the recycling facility (i.e., the weight of ~~materials leaving the recycling facility on a dry basis) segregated by material type.~~

recycled plastic waste or any other kind of raw material derived from plastics using chemical processes)[24] segregated by material type as defined in the latest version of the *Plastic Standard*. Where the output is of a chemically decomposed form of plastics and the material type can no longer be determined (i.e., in the case of chemical recycling), the material type must be determined based on the input to the depolymerization process, using a mass balance approach.[25]

~~4)~~7) ~~Credible evidence such as contractual agreements, receipts~~The quality of ~~sale of recycled material or third-party survey results can be provided to show that~~ the recycled ~~material supplied by~~plastic waste allows it to be used as feedstock in the ~~mechanical recycling facility will be used for processing or manufacturing~~manufacture of recycled products,[26] thereby displacing the use of virgin plastic. ~~In all cases, credible evidence shall be provided from a source~~Properties of the output of the recycling facility (e.g., presence and/or type of contamination, characteristics of macromolecules, chemical stability) may be used to demonstrate quality. Only the fraction of the output of the recycling facility that is or can be used to produce recycled plastics is eligible for WRCs. Any output that ~~can be verified by the validation/verification body (VVB).~~is used as a fuel, for energy recovery and/or as a chemical for any purpose other than plastic production is not eligible for WRCs.

Exceptions are made only for ~~projects that include~~ the recycling of composite materials that contain plastic~~, where the following shall be demonstrated~~ and other materials. Projects applying the exception must instead demonstrate that:

a) Plastic polymers cannot be separated out from the composite material and recycled independently (e.g., there is a lack of accessible or applicable technology in the market to separate the layers of the composite material to independently recycle each plastic component); and

b) The project implements a suitable application for the recycled material that is designed to be durable (i.e., lifetime of more than 10 years). This can be demonstrated through, among others, evidence of product development to extend the lifetime of the recycled product or results of product testing for durability. Independent quality studies of similar products (i.e., products made of a similar combination of materials, with similar characteristics to the materials in the project activity and a similar resulting application) may also be used to demonstrate durability. Where the project activity includes the manufacture of recycled products from composite materials, such applications ~~that~~must not combine the composite materials with other non-composite plastic waste such that it is not possible to separate the additional non-composite plastic materials for recycling after use~~ should be avoided.~~.

~~In all cases, credible evidence shall be provided to show that the waste materials will not be mixed with toxic materials or substances (e.g., coatings, adhesives or colorants) that could become~~

[24] This includes but is not limited to chemicals such as polymers, oligomers and monomers.
[25] For example, if the input to the depolymerization process consists of 50 percent HDPE, 30 percent LDPE and 20 percent composites (plastic only), the output would be assigned to the corresponding plastic material types using the same percentages.
[26] Recycled product as defined in Section 3 of this *Plastic Waste Recycling Methodology, v1.1*.

~~unsafe if compressed, combined or exposed to high temperatures during the recycling process. This can be demonstrated by providing a list of input materials and expected exposures during recycling. Where feasible and to distinguish themselves, projects may choose to demonstrate the quality of the recycled material based on standardized quality tests of representative samples of the recycled material.~~

Credible evidence such as contractual agreements, receipts of sale of recycled material, third-party audits, third-party survey results or chain of custody certification (e.g., ISCC PLUS) must be provided to demonstrate compliance with this applicability condition. In all cases, credible evidence must be provided from a source that can be verified by the validation/verification body (VVB).

~~5)~~8) There is recyclable plastic waste available in the region that would not have been recycled in the absence of the project. Availability of recyclable plastic waste may be demonstrated by, among others, using the most recent publicly available data on plastic waste generation and recycling rates in the region to show that there is plastic waste that is not being recycled.

9) Project activities that include any depolymerization of sorted plastic waste streams must justify why the materials in the sorted plastic waste stream cannot be recycled using any other technology or technologies resulting in a smaller relative reduction in (macro)molecular mass.[27] Credible evidence must be provided to demonstrate that such project activities meet one or more of the following conditions:

   a) Any recycling process resulting in a smaller reduction in (macro)molecular mass would not allow the output to displace the use of virgin feedstock for plastic production.

   b) The technology and/or process used in the project activity that results in a greater reduction in (macro)molecular mass has a lower energy intensity and/or lower GHG emissions compared to other technologies and/or processes that produce a similar quality output. For the comparison of technologies, the entire process from the exit of the sorting facility (if separate from the recycling facility) to the production of recycled plastic granulate must be included.

~~6)~~10) The project activity does not compete with other recycling activities or include plastic waste that has been diverted from a historically existing, legally recognized recycling activity. Evidence, such as proof of how the plastic waste was managed over the three-year period prior to implementation of the project activity, ~~shall~~must be provided to demonstrate that the project activity does not divert plastic waste from any historically existing, legally recognized recycling activity.

[27] In general, the greater the difference between the (macro)molecular mass of the input and that of the output of the recycling process, the greater the energy intensity of the overall waste reduction process (i.e., the process starting with plastic waste collection and ending with plastic production). Therefore, recycling technologies that reduce (macro)molecular mass as little as possible are generally preferable. For example, mechanical recycling of PET is preferable to pyrolysis, so long as the mechanically recycled PET can replace the production of new PET in the next lifecycle.

~~7)~~11) Plastic waste that enters the project recycling facility but is not recycled or is lost during the recycling process (e.g., due to contamination) is managed in a way that does not include dumping on open land, in water bodies and/or at dumpsites; open burning; or incineration without energy recovery. Where a project can reasonably only access one of these excluded end destinations, the project proponent ~~shall~~must demonstrate that the nature of the end destination is comparable to the plastic waste source and ~~shall~~must provide justification for why the project is not reasonably able to access an alternative end destination. In all cases, open dumping of plastic waste onto open land or into water bodies is not permitted.

If the plastic waste that was not recycled in the facility or the waste from the recycling activities contain hazardous substances, the waste must be managed through environmentally and socially appropriate technologies and processes in accordance with relevant national, regional or local regulations or guidelines.

This methodology is not applicable under the following conditions:

~~8)~~12) The plastic waste to be ~~mechanically~~ recycled has been collected in and imported from other countries, except in either or both of the following circumstances:

a) The project recycles plastic waste (using sustainable waste management practices) imported from a Least Developed Country (LDC)[28] or Small Island Developing State (SIDS).[29]

b) The project imports plastic waste from other countries for further processing where there is insufficient plastic waste available in the exporting country to enable development of recycling infrastructure at the time of project validation. Project proponents ~~shall~~must demonstrate the same through primary surveys or secondary literature available in the public domain and/or certified by a competent authority.[30]

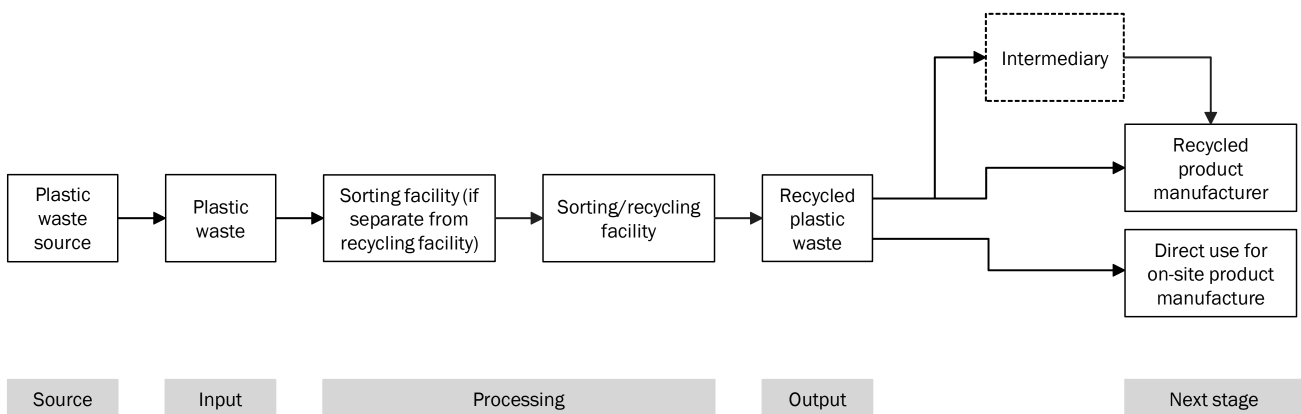
Where either or both of the above circumstances exist, a robust and transparent chain of custody from the source of plastic waste to the end destination of the project activity ~~shall~~must be provided.

[28] United Nations Conference on Trade and Development (n.d.). *UN List of Least Developed Countries.* Available at: https://unctad.org/en/Pages/ALDC/Least%20Developed%20Countries/UN-list-of-Least-Developed-Countries.aspx.
[29] United Nations Office of the High Representative for the Least Developed Countries, Landlocked Developing Countries and Small Island Developing States (n.d.). *List of SIDS*. Available at: https://www.un.org/ohrlls/content/list-sids.
[30] A competent authority denotes an entity that has been authorized by the concerned regulatory body or the overseeing local or national government body/department/ministry or an internationally recognized organization to execute and/or certify the task in question. The same is subject to verification by the VVB.

5 PROJECT BOUNDARY

The ~~spatial extent of the~~ project boundary is shown in Figure 1 and encompasses the following:

1) Plastic waste source;
2) Sorting facility, if separate from the recycling facility;
3) Facility where plastic waste is ~~mechanically~~ recycled up to the stage where recycled ~~materials are~~plastic waste is produced; and
4) Entity or entities that purchase recycled ~~material~~plastic waste from the recycling facility. The recycled plastic waste may also go through an intermediary process after recycling and before



6 BASELINE SCENARIO

The baseline scenario is that in which, without project implementation, the plastic waste would not have been recycled.

This methodology uses a project method to determine the crediting baseline, as outlined in Section 8.1.

7 DEMONSTRATION OF ADDITIONALITY

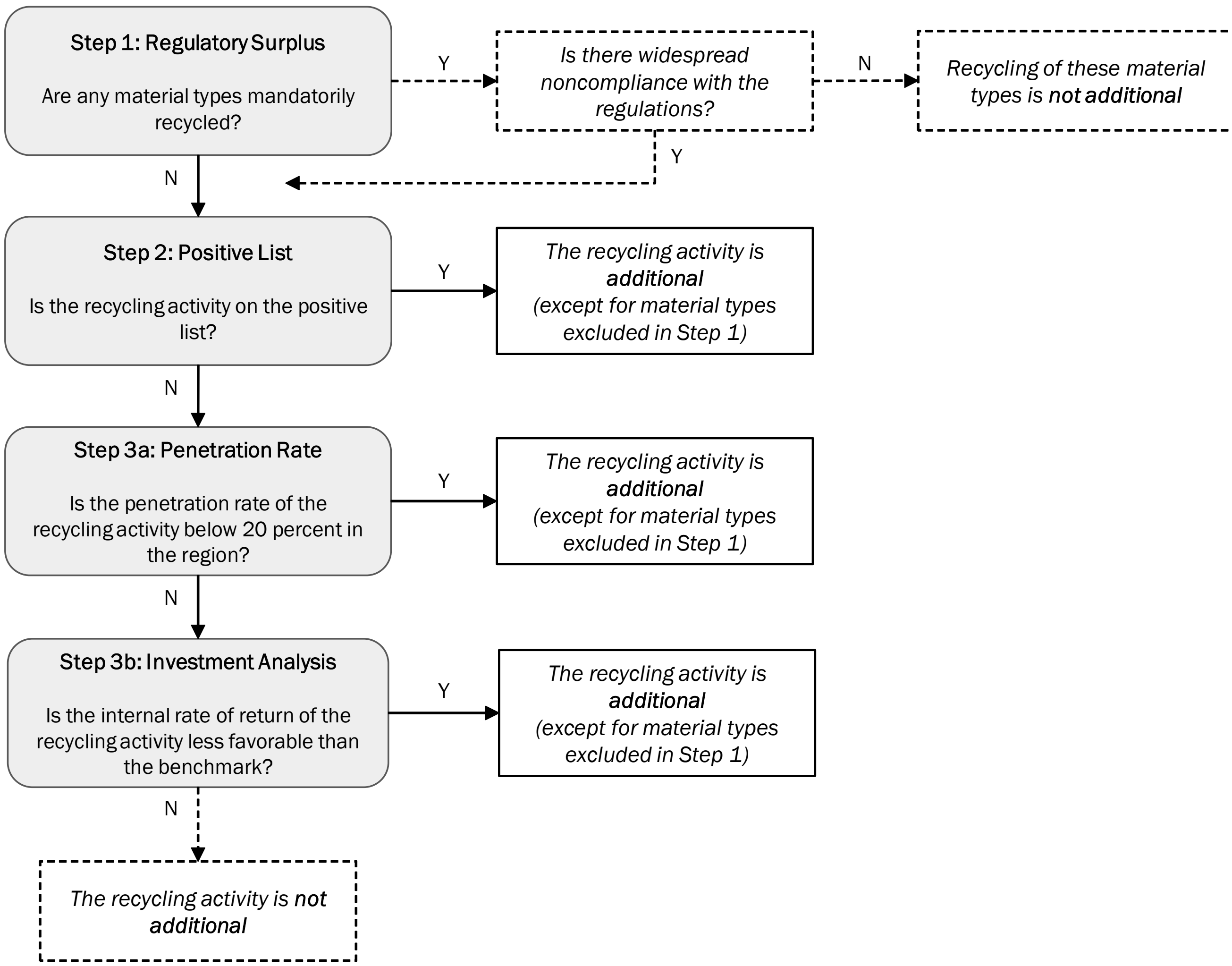
Project proponents applying this methodology must determine additionality using the procedure shown in Figure 2 and described below.

All project proponents must first apply Step 1 to demonstrate regulatory surplus for recycling of each individual material type managed in the project activity.

Project proponents must then apply Steps 2, 3a or 3b to demonstrate additionality of the project activity. These steps ~~shall~~must be applied sequentially, starting with Step 2 (positive list). If the project activity is not on the positive list and therefore not automatically deemed additional, the project proponent ~~shall~~must proceed to Step 3a (penetration rate). If the penetration rate of the project activity is greater than or equal to 20 percent, the project proponent ~~shall~~must apply Step 3b (investment analysis). These steps require all material types managed in the project activity to be assessed collectively to enable assessment at the project level.

Although not mandatory, project proponents may apply more than one of these steps, where possible, to strengthen the demonstration of additionality.

Note – The requirements in this section do not apply to projects that intend to use the Plastic Standard *solely for accounting purposes and not to issue ~~Waste Recycling Credits~~WRCs.*



Step 1: Regulatory Surplus

The project proponent ~~shall~~must demonstrate that the project activity proactively exceeds the current regulations or the regulatory compliance scenario based on the following guidance.

The project proponent ~~shall~~must list all relevant national, regional and local laws and regulations for plastic waste treatment and end use specific to recycling in the relevant region. This does not include national and local policies that do not have a legally binding status. Project proponents ~~shall~~must demonstrate whether, based on an examination of current practice in the region in which the law or regulation applies, those applicable legal or regulatory requirements are systematically enforced and whether noncompliance with those requirements is widespread in the host country.

This list should also include all extended producer responsibility (EPR) schemes relevant to the project activity and material type(s) in the region. The existence of relevant EPR schemes ~~shall~~must not be used to indicate an existing legal requirement for the project activity unless the specific EPR scheme is mandatory. Mandatory schemes may include, among others, those required by law, those that could result in legal redress, and those that enable authorities at the national, regional or local level to require brands or private companies to undertake recycling of the relevant material type(s).

An assessment ~~shall~~must be conducted for each material type included in the project activity to determine if legal or regulatory requirements for recycling are applicable. Recycling of a certain material type is not considered additional if it is mandatory. If the project proponent can demonstrate that their project activity will exceed a specific mandatory threshold for recycling of a certain material type, then project activities associated with the recycling of that material type may be considered additional.

Step 1 outcomes
Outcome 1: There are no laws or regulations that enforce recycling of the relevant material type(s) or the laws or regulations are not systematically enforced and noncompliance is widespread in the relevant country or region. Proceed to Step 2.
Outcome 2: There are laws and/or regulations that enforce recycling of some (but not all) of the material types recycled in the project activity. The recycling of these material types is not additional. Exclude the material types for which recycling is not additional and proceed to Step 2.
Outcome 3: There are laws and/or regulations that enforce recycling of all of the material types recycled in the project activity. Recycling of the material type(s) and the project activity are not additional.

Steps 2, 3a and 3b: Demonstrating Additionality of the Project Activity

Additionality of the project activity ~~shall~~must be demonstrated using one or more of the following three approaches: Steps 2 (positive list), 3a (penetration rate) and/or 3b (investment analysis). These steps ~~shall~~must be applied sequentially, with projects first applying Step 2 (positive list).

Step 2: Activity Method – Positive List[31]

Project activities are deemed automatically additional if the entire project activity, including all material types for which recycling is deemed additional in Step 1, constitutes at least one of the following. Both the plastic waste source and the recycling activity must be located in the region(s) specified.

- Recycling activity in a low-income country[32]
- Recycling activity in rural[33] areas of a lower-middle income country[34]
- Recycling activity including only mono-material flexible materials (e.g., films, carrier bags, pouches, pallet shrouds, including multi-layer plastics) or composite materials containing both plastic and non-plastic (both rigid and flexible, e.g., sachets, foils, envelopes, diapers, liquid packaging boards such as used beverage cartons) located in a lower-middle income country
- Recycling activity located on islands that can be classified as rural in a lower-middle or upper-middle income country[35]
- Recycling activity located in a Special Underdeveloped Zone (SUZ).[36] An SUZ is a region in the host country that has been identified by the government in official notifications for development assistance, including for planning, management and investment, and that satisfies any one of the following conditions using the most recent data available:

[31] Categories in the positive list have been determined based on the best data available on the extent of plastic waste recycling at the time the *Plastic Waste ~~Mechanical~~ Recycling Methodology, v1.~~0~~1* was developed. Project activities set in a context where the available data indicate that there is high confidence that the project activity will be additional are included in the positive list.
[32] The World Bank (2020). *World Bank Country and Lending Groups*. Available at: https://datahelpdesk.worldbank.org/knowledgebase/articles/906519.
[33] An administrative unit with a population density of less than 300 inhabitants per square kilometer (European Commission (2020). *A Recommendation on the Method to Delineate Cities, Urban and Rural Areas for International Statistical Comparisons*. Available at: https://unstats.un.org/unsd/statcom/51st-session/documents/BG-Item3j-Recommendation-E.pdf) or as defined in national regulations of the host country.
[34] The World Bank (2020). *World Bank Country and Lending Groups*. Available at: https://datahelpdesk.worldbank.org/knowledgebase/articles/906519.
[35] Ibid.
[36] Definition adopted from CDM (2018). *Methodological tool 19: Demonstration of additionality of microscale project activities, version 09.0*. Available at: https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-19-v9.pdf.

- The proportion of the population with income (i.e., purchasing power parity) of less than 2 USD per day in the region is greater than 50 percent;
- The gross national income (GNI) per capita in the host country is less than 3,000 USD and the population of the region is among the poorest 20 percent in the poverty ranking of the host country as per the applicable national policies and procedures; or
- The proportion of the population in the region with income less than the national poverty line used by the host country for reporting on the United Nations Sustainable Development Goals (SDGs) is greater than 50 percent.

Step 2 outcomes
Outcome 1: The project activity is included in the positive list. The project activity is additional (except for any material types excluded in Step 1).
Outcome 2: The project activity is not included in the positive list. Proceed to Step 3a (penetration rate).

Step 3a: Project Method – Penetration Rate of Recycling Activities

The project proponent ~~shall~~must assess the penetration rate of the project activity in the relevant region for all material types managed in the project activity (except for any material types excluded in Step 1). The penetration rate (percent) is given as the ratio between the total installed recycling capacity (tonnes/year) for plastic waste (including composite materials), excluding other project activities undergoing validation or that are already registered with the Plastic Program, and plastic waste production (tonnes/year) in the region. If this penetration rate is below 20 percent,[37] the project activity, including all material types recycled (other than any material types excluded in Step 1), is additional.

Any data or studies used in Step 3a to determine the penetration rate ~~shall~~must be no more than three years old at the time of validation.

The penetration rate of the project activity ~~shall~~must be assessed in accordance with the following:

1) The relevant region for which the values are being determined ~~shall~~must be the same as the collection area of the project activity for all project activities, except those included in Applicability Condition ~~8~~12.
2) For activities that recycle plastic waste that has been collected in and imported from other countries (as per Applicability Condition ~~8b~~12b), the region used for this assessment ~~shall~~must be the entire country where the recycling activity is implemented.
3) The total generation of plastic waste (including composites), *G* (tonnes/year), in the region ~~shall~~must be determined using one of the following approaches:
    a) Publicly available information (e.g., data from governments, local authorities, third-party studies); or
    b) Based on population size in the region and plastic waste generation rates (kg/year per capita). If the project can demonstrate that there is no publicly available data on plastic waste generation rates and it is not reasonable to undertake market research due to a lack of technical, financial or temporal capacity, then the default values included in Table 1 may be applied to all material types within the project activity.

[37] Following the 20 percent common practice threshold in CDM (2015). *Methodological tool 24: Common practice, version 03.1.* Available at: https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-24-v1.pdf.

Table 1: Default values for plastic waste generation rates (kg/year per capita)[38]

Country	Urban[39]	Rural[40]
High income	76	76
Upper-middle income	31	21
Lower-middle income	21	11
Lower income	18	9

Where significant pre-existing plastic waste stocks (e.g., from landfills[41]) are available for recycling at validation in addition to plastic waste generated in the region, these ~~can~~may be included in *G* in amounts proportional to the first crediting period of the project. This ~~shall~~must be calculated by dividing the total recoverable amount available at validation by the number of years of the first crediting period. Evidence such as inventories from the landfill operator or third-party studies ~~shall~~must be provided and assumptions ~~shall~~must be conservative.

4) The total installed recycling capacity for plastic waste (including composite materials), *C* (tonnes/year), of all legally recognized recycling facilities that recycle plastic waste in the region ~~shall~~must be determined, based on data from local authorities or independent market research and excluding other plastic recycling project activities undergoing validation or that are already registered with the Plastic Program. Where such data are not available, the project proponent ~~shall~~must demonstrate how this capacity is determined in a credible way.

[38] The figures in Table 1 were determined using values from Lau, W.W.Y. et al. (2020). Evaluating scenarios toward zero plastic pollution. *Science* 369, 1455-1461. Available at: https://doi.org/10.1126/science.aba9475. Plastic waste generated (Mt; Table S11) is divided by population (in millions; Table S10) in 2016 for each income category for both urban and rural areas. The authors recognize that waste generation and recycling rates may differ among material types, and there are data gaps within their study. The data are based on information from The World Bank and are provided as the most globally applicable dataset available at the time of publication of the *Plastic Waste ~~Mechanical~~ Recycling Methodology, v1.~~0~~1*. This default dataset may be updated with subsequent revisions of the methodology as more accurate data become widely available.

[39] An administrative unit with a population density of at least 300 inhabitants per square kilometer (European Commission (2020). *A Recommendation on the Method to Delineate Cities, Urban and Rural Areas for International Statistical Comparisons*. Available at: https://unstats.un.org/unsd/statcom/51st-session/documents/BG-Item3j-Recommendation-E.pdf) or as defined in national regulations of the host country.

[40] An administrative unit with a population density of less than 300 inhabitants per square kilometer (European Commission (2020). *A Recommendation on the Method to Delineate Cities, Urban and Rural Areas for International Statistical Comparisons*. Available at: https://unstats.un.org/unsd/statcom/51st-session/documents/BG-Item3j-Recommendation-E.pdf) or as defined in national regulations of the host country.

[41] Other examples of significant pre-existing plastic waste stocks include cases in which plastic waste has been collected from the environment but insufficient financial means exist to process the waste, thus it is left in a local site that is not a landfill, or where plastic waste has accumulated in the environment (e.g., in a ditch or along riverbanks).

5) Only plastic waste that ~~can~~may be realistically collected and recycled ~~shall~~must be accounted for. Where the project activity includes a specific material type for which reliable, publicly available information indicates that the penetration rate is higher than the average penetration rate calculated for all material types within the project activity combined, the calculation ~~shall~~must focus on this material type only.

6) The penetration rate (%), which is the ratio between the total installed recycling capacity and total plastic waste generation, ~~shall~~must be determined using the following equation:

$$Penetration\ Rate = \frac{C}{G} \times 100$$

(Equation 1)

Step 3a outcomes
Outcome 1: If the project activity has a penetration rate less than 20 percent, the project activity is additional (except for those material types excluded in Step 1).
Outcome 2: If the project activity has a penetration rate greater than or equal to 20 percent, proceed to Step 3b (investment analysis).

Step 3b: Project Method – Investment Analysis

The objective of the investment analysis is to demonstrate that the project activity is not economically or financially attractive.

The project proponent ~~shall~~must carry out the investment analysis using "Option III: Apply benchmark analysis," including the sensitivity analysis, prescribed in the latest version of the CDM's *Tool for the demonstration and assessment of additionality*. The latest approved versions of the methodological tools for *Demonstration and assessment of additionality* and *Investment analysis* ~~shall~~must be used when applying this step. The following additional guidance should be taken into account for the investment analysis of the project activity, combined for all material types, except for those material types excluded in Step 1:

1) The internal rate of return (IRR) of the project activity ~~shall~~must be used as the financial indicator.

2) Financial analysis ~~shall~~must be based on parameters that are standard in the market and not linked to the subjective profitability expectation or risk profile of a particular project proponent. Where the project activity can only be implemented by the project proponent (e.g., for capacity addition projects), the specific financial situation of the company undertaking the project activity may be considered.

3) All relevant costs[42] and revenues (excluding revenues from Plastic Credits, but including revenues from the sale of recycled material, and other revenues such as subsidies,[43] or other fiscal incentives, where applicable) ~~shall~~must be included.

4) Where project activities share equipment or resources with other waste processing activities, such as ~~chemical recycling or~~ incineration with energy recovery, only the allocated costs[44] and revenues[45] for ~~mechanical~~ recycling of material types for which regulatory surplus is demonstrated in Step 1 ~~shall~~must be included in the assessment. The cost allocation ~~shall~~must be conservative.

5) Benchmarks ~~shall~~must be derived from one of the following options:

    a) Government bond rates, increased by a suitable risk premium to reflect private investment and/or the project type, as substantiated by an independent (financial) expert or documented by official, publicly available financial data;

    b) Estimates of the cost of financing and required return on capital (e.g., commercial lending rates and guarantees required for the recycling activity), based on bankers' views and return required by private equity investors/funds for comparable projects;

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[42] For example, investment; capital that needs to be repaid (e.g., loans); operational and maintenance (O&M) costs, such as the cost of sorting, shredding and recycling machinery; environmental equipment (e.g., water or air filters); staff wages; plastic waste materials; electricity usage.
[43] For example, grants that do not need to be repaid, soft loans, contribution to O&M costs or deficit guarantees.
[44] For example, investment costs of sorting equipment used by ~~both mechanical and chemical~~multiple recycling activities or shared O&M costs.
[45] For example, from the sale of energy, savings from energy purchase or sales from chemical recycling outputs.

c) A company internal benchmark (the company's weighted average cost of capital), only in the particular case referred to in 2 of Step 3b. The project proponent ~~shall~~must demonstrate that this benchmark has been consistently used in the past, i.e., that project activities under similar conditions developed by the same company used the same benchmark;

d) Government/official approved benchmark where such benchmarks are used for investment decisions; or

e) Any other indicators, if the project proponents can demonstrate that the above options are not applicable and justification of the indicator is deemed appropriate by the VVB.

6) The investment analysis ~~shall~~must be provided in a transparent manner and ~~shall~~must include all relevant assumptions, preferably in the project description, or in a separate annex to the project description, so that a reader can reproduce the analysis and obtain the same results. The analysis ~~shall~~must refer to all critical techno-economic parameters and assumptions (e.g., capital costs, sale prices of the relevant material type(s), project lifetime) and justify assumptions in a manner that can be validated by the VVB.

7) A clear comparison of the financial indicator for the project activity and the financial benchmark ~~shall~~must be presented in the project description submitted for validation. If the project activity has a less favorable indicator (i.e., lower IRR) than the benchmark, the project activity cannot be considered financially attractive.

8) A sensitivity analysis ~~shall~~must be conducted as outlined in Section 7 in the CDM's *Methodological tool 27: Investment analysis* to show whether the conclusion regarding financial attractiveness is robust to reasonable variations in the key assumptions. The investment analysis provides a valid argument in favor of additionality only if it consistently supports (for a realistic range of assumptions) the conclusion that the project activity is unlikely to be financially attractive.

Step 3b outcomes
Outcome 1: If the IRR of the project activity is below the benchmark in all realistic scenarios of the sensitivity analysis, the project activity is additional (except for those material types excluded in Step 1).
Outcome 2: If the IRR of the project activity is above the benchmark in at least one of the realistic scenarios included in the sensitivity analysis, the project activity is not additional.

8 QUANTIFICATION OF PLASTIC WASTE RECYCLING

Project proponents ~~shall~~must use the equations below to calculate the amount of plastic waste recycled at baseline, the total amount of plastic waste recycled by the project activity and the additional amount of plastic waste recycled as a result of the project activity. The equations ~~shall~~must be applied only for material types for which recycling activities are additional as outlined in Step 1 of Section 7.

8.1 Baseline Recycling

Baseline recycled plastic waste is the amount of plastic waste that would have been recycled in the absence of the project activity.

Baseline recycled plastic waste is calculated as follows:

$$B_{recycled,y} = \cancel{\sum_{i=1}^{n} B_{recycled,i,y} \times AF_i} \sum_{i=1}^{n} B_{p,recycled,i,y} \times AF_i + \sum_{i=1}^{n} B_{dp,recycled,i,y} \times MF$$

(Equation 2)

Where:

~~$B_{recycled,y}$ = Baseline recycled plastic waste in year *y* (tonnes)~~

~~$B_{recycled,i,y}$ = Baseline recycled plastic waste of material type *i* in year *y* (tonnes)~~

~~AF_i = Adjustment factor for composite material *i*; for non-composite materials, this factor is equal to 1.~~

$B_{recycled,y}$	= Baseline amount of recycled plastic waste in year *y* (tonnes)
$B_{p,recycled,i,y}$	= Baseline amount of recycled plastic waste of material type *i* in year *y* (tonnes) without depolymerization
AF_i	= Adjustment factor for composite material *i*; for non-composite materials, this factor is equal to 1
$B_{dp,recycled,i,y}$	= Baseline amount of recycled plastic waste in the form of depolymerized plastics from material type *i* in year *y* (tonnes). Since the material type can no longer be determined based on the output, it must be determined based on the input to the depolymerization process, using a mass balance approach.
MF	= Mass fraction of the output of the depolymerization process used for plastic production

The baseline recycled plastic waste for material type *i* is determined as follows:

1) For a new activity, use the following:

    a) Baseline recycling equals zero, $\cancel{B_{recycled,i,y} =} B_{p,recycled,i,y} + B_{dp,recycled,i,y} = 0$

2) For a capacity addition activity or technology improvement to an existing facility that results in increased recycling capacity,[46] use one of the following options:

    a) Baseline recycling 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;

    b) If the facility has been operational for between one and three years, use the average annual recycling rate of material type *i* for the period from the operational start date of the existing facility until the start of the project activity; or

    c) If the operational period before the capacity addition is less than one year, baseline recycling is capped at the total recycling capacity of the existing facility prior to the capacity addition as given by the manufacturer's specifications. In this case, it ~~shall~~must be assumed that the recycling capacity for each material type *i* is equal to the maximum recycling capacity of the facility for that material type.

3) When a project activity is incentivizing and/or facilitating an increase in the collection and/or sorting of plastic waste to enable an increase in its ~~mechanical~~ recycling, use one of the following options:

    a) Baseline recycling 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;

    b) If the facility has been operational for between one and three years, use the average annual recycling rate of material type *i* for the period from the operational start date of the existing facility until the start of the project activity; or

    c) If the facility has been operational for less than one year, the baseline recycling rate ~~shall~~must be established in a reasonable and conservative manner (e.g., based on existing sources of plastic waste and projected recycling rates of this plastic waste without the implementation of the project activity) such that it can be validated by the VVB.

[46] 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.

Adjustment factor for composite materials containing non-plastic materials

Project activities that recycle composite materials containing both plastic and non-plastic materials that meet Applicability Condition ~~5 shall~~7) must only account for the fraction of plastic within the composite material. Such project activities ~~shall~~must apply an adjustment factor, *AF*, to account for the amount of plastic within the composite material. The adjustment factor ~~shall~~must be determined using one of the following options:

1) Apply the default factors listed in Table 2 that correspond to the composite materials recycled.

Table 2: Default factors for plastic waste fraction of composite materials

Composite application	Plastic fraction
Composite material (unspecified)	0.04
Used beverage cartons[47]	0.20
Paper cups (with polyethylene)[48]	0.05
E-waste[49]	0.04

2) Use sampling to determine the fraction of plastic in the composite material following the most recent version of the CDM's *Standard: Sampling and surveys for CDM project activities and programmes of activities*[50] in conjunction with the guidance below:

    a) Projects ~~shall~~must use 90/10 confidence/precision to establish the reliability of sampling efforts and undertake sampling of composite materials at least every six months. For composite materials with a material composition that does not change over time (e.g., recycling of a certain type of beverage carton), sampling may be done only once at validation or first verification and the same plastic waste fraction can be used for the remainder of the crediting period.

    b) The sampling method ~~shall~~must be detailed in the monitoring plan and applied using the following guidelines:

[47] A conservative default factor was identified using material composition of Tetra Pak beverage cartons from the manufacturer's 2018 and 2020 sustainability reports. Available at: https://assets.tetrapak.com/static/documents/sustainability/tetra-pak-sustainability-report-2018.pdf and https://assets.tetrapak.com/static/documents/sustainability/sustainability-report2020.pdf.

[48] Default value taken from European Commission (2018). *Life Cycle Inventories of Single Use Plastic Products and their Alternatives*. Available at: https://ec.europa.eu/environment/enveco/circular_economy/pdf/studies/DG%20ENV%20Single%20Use%20Plastics%20LCA%20181213.pdf.

[49] Default value taken from Alassali, A. et al. (2019). Classification of plastic waste originated from waste electric and electronic equipment based on the concentration of antimony. *Journal of Hazardous Materials* 380, 120874. Available at: https://doi.org/10.1016/j.jhazmat.2019.120874.

[50] Available at: https://cdm.unfccc.int/Reference/Standards/index.html.

i) The plastic fraction ~~shall~~must be calculated as a mean value.

ii) The sample size ~~shall~~must be determined before starting the sampling process using Equation 18 in “2.1.7 Example 5 – Simple random sampling” in Appendix 1 of the CDM’s *Guideline: Sampling and Surveys for CDM project activities and programmes of activities, version 04.0*.[51]

iii) After the sampling process, if the actual sample results do not meet the 90/10 confidence/precision required to establish the reliability of sampling, then a larger sample size may be proposed, updating the expected mean value and variation, and the sampling process may be undertaken again to meet 90/10 confidence/precision.

iv) Where the project activity recycles more than one type of composite material (e.g., different product or packaging applications, different material combinations), and they are identified separately in the input stream of the recycling process, then sampling for plastic fraction ~~shall~~must be done for each composite material type separately.

The plastic fraction value of each composite material will be multiplied directly by the weight of the composite material type to determine the weight of the plastic (see Equations 2 and 3 in this methodology).

The same adjustment factor ~~shall~~must be applied to both the calculation of baseline recycled plastic waste (in case of capacity addition activities) and the project recycled plastic waste.

[51] Available at: https://cdm.unfccc.int/Reference/Guidclarif/index.html.

8.2 Project Recycling

Project recycled plastic waste is the amount of plastic waste that is recycled by the project activity.

Project recycled plastic waste is calculated as follows:

$$P_{recycled,y} = \cancel{\sum_{i=1}^{n} P_{recycled,i,y} \times AF_i} \sum_{i=1}^{n} P_{p,recycled,i,y} \times AF_i + \sum_{i=1}^{n} P_{dp,recycled,i,y} \times MF$$

(Equation 3)

Where:

~~$P_{recycled,y}$ = Total plastic waste recycled by the project activity in year *y* (tonnes)~~

~~$P_{recycled,i,y}$ = Amount of plastic waste of material type *i* recycled by the project activity in year *y* (tonnes)~~

~~AF_i = Adjustment factor for composite material *i* (see Adjustment factor under Section 8.1); for non-composite materials, this factor is equal to 1.~~

$P_{recycled,y}$	= Total amount of plastic waste recycled by the project activity in year *y* (tonnes)
$P_{p,recycled,i,y}$	= Amount of plastic waste of material type *i* recycled by the project activity in year *y* (tonnes) without depolymerization
AF_i	= Adjustment factor for composite material *i* (see Adjustment factor under Section 8.1); for non-composite materials, this factor is equal to 1.
$P_{dp,recycled,i,y}$	= Amount of plastic waste in the form of depolymerized plastics of material type *i* recycled by the project activity in year *y* (tonnes). Since the material type can no longer be determined based on the output, it must be determined based on the input to the depolymerization process, using a mass balance approach.
MF	= Mass fraction of the output of the depolymerization process used for plastic production

8.3 Net Recycled Plastic Waste

The net recycled plastic waste is the amount of plastic waste recycled by the project activity that would not have been recycled without project implementation.

Net recycled plastic waste is calculated as follows:

$$N_{recycled,y} = \quad P_{recycled,y} - B_{recycled,y}$$

(Equation 4)

Where:

$N_{recycled,y}$ = Net recycled plastic waste in year *y* (tonnes)

9 MONITORING

9.1 Data and Parameters Available at Validation

The baseline plastic waste recycling parameter ~~shall~~must be recorded in the project description and available at the time of validation. For baseline plastic waste recycling, projects that include a new recycling activity ~~shall~~must use ~~Table 3a~~Tables 3a, 3b and/or 3c, and projects that include a capacity addition activity ~~shall~~must use ~~Table 3b.~~Tables 3d, 3e and/or 3f. Projects that incentivize and/or facilitate an increase in the collection and/or sorting of plastic waste to enable an increase in its ~~mechanical recycling shall use Table 3c.~~recycling must use Tables 3g, 3h and/or 3i.

Table ~~3a~~3a: Baseline recycling parameter (new activity)

Data/Parameter	$B_{recycled,i,y}$
Unit	tonnes/year
Description	Amount of material type *i* recycled in the baseline in year *y*
Equation	-
Source of data	-
Justification of choice of data or description of measurement methods and procedures applied	Baseline plastic waste recycling is zero for new project activities (see Section ~~8.1)~~8.1).
Purpose	Determination of baseline plastic waste recycling for new activities
Comments	-

Table 3b: Baseline recycling parameter (new activity)

Data/Parameter	$B_{p,recycled,i,y}$
Unit	tonnes/year
Description	Amount of material type *i* recycled without depolymerization in the baseline in year *y*
Equation	-
Source of data	-
Justification of choice of data or description of measurement methods and procedures applied	Baseline plastic waste recycling is zero for new project activities (see Section 8.1).
Purpose	Determination of baseline plastic waste recycling for new activities
Comments	-

Table 3c: Baseline recycling parameter (new activity)

Data/Parameter	$B_{dp,recycled,i,y}$
Unit	tonnes/year
Description	Amount of material type *i* recycled in the form of depolymerized plastics in the baseline in year *y*
Equation	-
Source of data	-
Justification of choice of data or description of measurement methods and procedures applied	Baseline plastic waste recycling is zero for new project activities (see Section 8.1).
Purpose	Determination of baseline plastic waste recycling for new activities
Comments	-

Table 3d: Baseline recycling parameter (capacity addition activity)

Data/Parameter	$B_{recycled,i,y}$
Unit	tonnes/year
Description	Amount of material type *i* recycled in the baseline in year *y*
Equation	Equation 2
Source of data	Based on historical data of recycled material type *i* or capped at the total recycling capacity of the existing facility (see Section 8.1)
Justification of choice of data or description of measurement methods and procedures applied	One of the following ~~shall~~must be applied: a) Average annual recycling rate of material type *i* over the three-year period prior to the start of the project activity; b) If the facility has been operational for between one and three years, use the average annual recycling rate of material type *i* over the period from the operational start date of the existing facility until the start of the project activity; or c) If the operational period before the capacity addition is less than one year, baseline recycling is capped at the total recycling capacity of the existing facility prior to the capacity addition, as given by the manufacturer's specifications. In this case, it ~~shall~~must be assumed that the recycling capacity for each material type *i* is equal to the maximum recycling capacity of the facility for that material type.
Purpose	Determination of baseline plastic waste recycling for capacity addition projects
Comments	-

Table ~~3c~~3e: Baseline recycling parameter (capacity addition activity)

Data/Parameter	$B_{p,recycled,i,y}$
Unit	tonnes/year
Description	Amount of material type *i* recycled without depolymerization in the baseline in year *y*
Equation	Equation 2
Source of data	Based on historical data of recycled material type *i* or capped at the total recycling capacity of the existing facility (see Section 8.1)
Justification of choice of data or description of measurement methods and procedures applied	One of the following must be applied: a) Average annual recycling rate of material type *i* over the three-year period prior to the start of the project activity; b) If the facility has been operational for between one and three years, use the average annual recycling rate of material type *i* over the period from the operational start date of the existing facility until the start of the project activity; or c) If the operational period before the capacity addition is less than one year, baseline recycling is capped at the total recycling capacity of the existing facility prior to the capacity addition, as given by the manufacturer's specifications. In this case, it must be assumed that the recycling capacity for each material type *i* is equal to the maximum recycling capacity of the facility for that material type.
Purpose	Determination of baseline plastic waste recycling for capacity addition projects
Comments	-

Table 3f: Baseline recycling parameter (capacity addition activity)

Data/Parameter	$B_{dp,recycled,i,y}$
Unit	tonnes/year
Description	Amount of material type *i* recycled in the form of depolymerized plastics in the baseline in year *y*
Equation	Equation 2
Source of data	Based on historical data of recycled material type *i* or capped at the total recycling capacity of the existing facility (see Section 8.1)
Justification of choice of data or description of measurement methods and procedures applied	One of the following must be applied: a) Average annual recycling rate of material type *i* over the three-year period prior to the start of the project activity; b) If the facility has been operational for between one and three years, use the average annual recycling rate of material type *i* over the period from the operational start date of the existing facility until the start of the project activity; or c) If the operational period before the capacity addition is less than one year, baseline recycling is capped at the total recycling capacity of the existing facility prior to the capacity addition, as given by the manufacturer's specifications. In this case, it must be assumed that the recycling capacity for each material type *i* is equal to the maximum recycling capacity of the facility for that material type.
Purpose	Determination of baseline plastic waste recycling for capacity addition projects
Comments	-

Table 3g: Baseline recycling parameter (increased ~~mechanical~~ recycling enabled by increased collection and/or sorting)

Data/Parameter	$B_{recycled,i,y}$
Unit	tonnes/year
Description	Amount of material type *i* recycled in the baseline in year *y*
Equation	Equation 2
Source of data	Based on historical data of recycled material type *i* or established in a reasonable and conservative manner (see Section 8.1)
Justification of choice of data or description of measurement methods and procedures applied	One of the following ~~shall~~must be applied: a) Average annual recycling rate of material type *i* over the three-year period prior to the start of the project activity; b) If the facility has been operational for between one and three years, use the average annual recycling rate of material type *i* over the period from the operational start date of the existing facility until the start of the project activity; or c) If the facility has been operational for less than one year, baseline recycling ~~shall~~must be established in a reasonable and conservative manner such that it can be validated by the VVB.
Purpose	Determination of baseline plastic waste recycling for projects that incentivize and/or facilitate an increase in the collection and/or sorting of plastic waste to enable an increase in its ~~mechanical~~ recycling
Comments	-

Table 3h: Baseline recycling parameter (increased recycling enabled by increased collection and/or sorting)

Data/Parameter	$B_{p,recycled,i,y}$
Unit	tonnes/year
Description	Amount of material type *i* recycled without depolymerization in the baseline in year *y*
Equation	Equation 2
Source of data	Based on historical data of recycled material type *i* or established in a reasonable and conservative manner (see Section 8.1)
Justification of choice of data or description of measurement methods and procedures applied	One of the following must be applied: a) Average annual recycling rate of material type *i* over the three-year period prior to the start of the project activity; b) If the facility has been operational for between one and three years, use the average annual recycling rate of material type *i* over the period from the operational start date of the existing facility until the start of the project activity; or c) If the facility has been operational for less than one year, baseline recycling must be established in a reasonable and conservative manner such that it can be validated by the VVB.
Purpose	Determination of baseline plastic waste recycling for projects that incentivize and/or facilitate an increase in the collection and/or sorting of plastic waste to enable an increase in its recycling
Comments	-

Table 3i: Baseline recycling parameter (increased recycling enabled by increased collection and/or sorting)

Data/Parameter	$B_{dp,recycled,i,y}$
Unit	tonnes/year
Description	Amount of material type *i* recycled in the form of depolymerized plastics in the baseline in year *y*
Equation	Equation 2
Source of data	Based on historical data of recycled material type *i* or established in a reasonable and conservative manner (see Section 8.1)
Justification of choice of data or description of measurement methods and procedures applied	One of the following must be applied: a) Average annual recycling rate of material type *i* over the three-year period prior to the start of the project activity; b) If the facility has been operational for between one and three years, use the average annual recycling rate of material type *i* over the period from the operational start date of the existing facility until the start of the project activity; or c) If the facility has been operational for less than one year, baseline recycling must be established in a reasonable and conservative manner such that it can be validated by the VVB.
Purpose	Determination of baseline plastic waste recycling for projects that incentivize and/or facilitate an increase in the collection and/or sorting of plastic waste to enable an increase in its recycling
Comments	-

9.2 Data and Parameters Monitored

The following parameters ~~shall~~must be monitored and recorded during the crediting period.

Table ~~4:~~4: Sorting output parameter

Data/Parameter	Sorting output
Unit	Material type *i* (see the latest version of the *Plastic Standard*) Quantity (tonnes/year)
Description	Quantity of sorted plastic waste of each material type *i*
Equation	-
Source of data	On-site measurement
Description of measurement methods and procedures applied	Measurement of each material type *i* with weighing scales after sorting of waste
Frequency of monitoring/recording	Recorded at the time of sending each batch of sorted plastic waste from the sorting facility to the recycling facility
Quality assurance/quality control (QA/QC) procedures applied	Scales must be calibrated according to the equipment manufacturer's specifications or at least every three years. If the sorting facility is separate from the recycling facility, the quantity of material type *i* must be cross-checked with the sales receipt of sorted plastic waste of material type *i* sold to the recycling facility.
Purpose	Monitoring for compliance with Applicability Condition 4 in Section 4
Comments	Where hazardous material is found during sorting, it must be eliminated and/or disposed of and removed from the process following relevant national, regional and local regulations

Table 5: Project recycling input parameter

Data/Parameter	Recycling input
Unit	Dimensionless
Description	List of input materials (e.g., solvents, process fuels) to the recycling process. This includes the category of plastic waste of material type *i* and any other material(s) used in the recycling process.
Equation	-
Source of data	On-site records
Description of measurement methods and procedures applied	-
Frequency of monitoring/recording	Recorded prior to each batch of sorted plastic waste entering the recycling process
Quality assurance/quality control (QA/QC) procedures applied	Where hazardous material is found in the input to the recycling process, it must be eliminated from the process following national, regional and local regulations.
Purpose	Monitoring for compliance with Applicability Condition 5 in Section 4
Comments	-

Table 6a: Project recycling parameter

Data/Parameter	$P_{recycled,i,y}$
Unit	tonnes/year
Description	Amount of plastic waste of material type *i* recycled by the project activity in year *y* (tonnes)
Equation	Equation 3
Source of data	Direct measurement at project facility

Description of measurement methods and procedures applied	Measurement of each material type *i* with weighing scales after the final stage at the recycling facility, before leaving the project site or being used for manufacturing products ~~onsite~~on site
Frequency of monitoring/recording	~~Each batch, with at least daily recording~~Recorded at the time of sending each batch of recycled plastic waste from the recycling facility to the processing or manufacturing facility, to other customers or before use on site
Quality assurance/quality control (QA/QC) procedures applied	Scales ~~shall~~must be calibrated according to the equipment manufacturer's specifications or at least every three years. Amount of ~~plastic~~ recycled ~~shall~~plastic waste and quality must be cross-checked with sales receipts of material sold to final buyer, or other equivalent third-party evidence.
Purpose	Calculation of baseline recycled plastic waste Calculation of project recycled plastic waste Monitoring for compliance with Applicability Condition 7 in Section 4
Comments	If plastic is washed, it should be weighed after it has been dried. Only material types for which recycling activities are determined to be additional at validation are included for crediting.

Table 6b: Project recycling parameter

Data/Parameter	$P_{p,recycled,i,y}$
Unit	tonnes/year
Description	Amount of plastic waste of material type *i* recycled without depolymerization by the project activity in year *y* that is of a quality such that it can be used to displace virgin plastic in the manufacture of recycled products
Equation	Equation 3
Source of data	Direct measurement at project facility

Description of measurement methods and procedures applied	Measurement of each material type *i* with weighing scales after the final stage at the recycling facility, before leaving the project site or being used for manufacturing products on site
Frequency of monitoring/recording	Recorded at the time of sending each batch of recycled plastic waste from the recycling facility to the processing or manufacturing facility, to other customers or before use on site
Quality assurance/quality control (QA/QC) procedures applied	Scales must be calibrated according to the equipment manufacturer's specifications or at least every three years. Amount of recycled plastic waste and quality must be cross-checked with sales receipts of material sold to final buyer, or other equivalent third-party evidence.
Purpose	Calculation of baseline recycled plastic waste Calculation of project recycled plastic waste Monitoring for compliance with Applicability Condition 7 in Section 4
Comments	If plastic is washed, it should be weighed after it has been dried. Only material types for which recycling activities are determined to be additional at validation are included for crediting.

Table ~~5:~~6c: Project recycling parameter

Data/Parameter	$P_{dp,recycled,i,y}$
Unit	tonnes/year
Description	Amount of plastic waste of material type *i* recycled in the form of depolymerized plastics by the project activity in year *y* that is of a quality such that it can be used to displace virgin plastic in the manufacture of recycled products
Equation	Equation 3
Source of data	Direct measurement at project facility
Description of measurement methods and procedures applied	Measurement of each material type *i* with weighing scales after the final stage at the recycling facility, before leaving the project site or being used for manufacturing products on site Where the output is a chemically decomposed form of plastics and the material type can no longer be determined, the material type must be determined based on the input to the depolymerization process, using a mass balance approach.
Frequency of monitoring/recording	Recorded at the time of sending each batch of recycled plastic waste from the recycling facility to the processing or manufacturing facility, to other customers or before use on site
Quality assurance/quality control (QA/QC) procedures applied	Scales must be calibrated according to the equipment manufacturer's specifications or at least every three years. Amount of recycled plastic waste and quality must be cross-checked with sales receipts of material sold to final buyer, or other equivalent third-party evidence.
Purpose	Calculation of baseline recycled plastic waste Calculation of project recycled plastic waste Monitoring for compliance with Applicability Condition 7 in Section 4
Comments	Only material types for which recycling activities are determined to be additional at validation are included for crediting.

	The amount of recycled plastic waste of material type *i* in the form of depolymerized plastics is used to calculate the mass fraction parameter (Table 8).

Table 7: Adjustment factor for composite materials containing non-plastic materials

Data/Parameter	$\boldsymbol{AF_i}$
Unit	-
Description	Adjustment factor for composite material *i*
Equation	Equations 2 and 3
Source of data	One of the following: a) Apply the default factors listed in Table 2 that correspond to the composite materials recycled; or b) Use sampling to determine the fraction of plastic in the composite material following the most recent version of the CDM's *Standard: Sampling and surveys for CDM project activities and programmes of activities*[52] (see Adjustment factor under Section 8.1 of this methodology).
Description of measurement methods and procedures applied	One of the following: a) Apply the default factors listed in Table 2 that correspond to the composite materials recycled; or b) Apply the sampling method using the guidelines in Section 8.1.
Frequency of monitoring/recording	For projects applying the default factors listed in Table 2, this is not applicable. Projects using 90/10 confidence/precision to establish the reliability of sampling efforts ~~shall~~must undertake sampling of composite materials at least every 6 months. For composite materials with a material composition that does not change over time (e.g., recycling of a certain type of beverage carton), sampling may be done only once at validation or first verification and the same plastic waste fraction can be used for the remaining crediting period.
Quality assurance/quality control (QA/QC) procedures applied	-
Purpose	Calculation of baseline recycled plastic waste

[52] Available at: https://cdm.unfccc.int/Reference/Standards/index.html.

	Calculation of project recycled plastic waste
Comments	-

~~Table 6:~~Table 8: Mass fraction for monomers and oligomers to plastics

Data/Parameter	MF
Unit	-
Description	Mass fraction of the output of the depolymerization process used for plastic production
Equation	Equations 2 and 3
Source of data	Third-party evidence (e.g., receipts, on-site measurements of chemical process inputs and outputs)
Description of measurement methods and procedures applied	Mass used for plastic production divided by the total mass of depolymerized plastics in the output of the recycling facility. The mass used for plastic production may be calculated using a mass balance approach if the project output is mixed with other inputs in subsequent processes.[53] The mass used for plastic production must be measured at the earliest possible point where it can be demonstrated that the raw material is only being used for plastic production (e.g., when being sold to a plastic producer). Any fillers in the depolymerized plastic output must not be included in the calculation of the mass fraction.
Frequency of monitoring/recording	Recorded at the time of sending each batch of recycled plastic waste from the recycling facility to the processing or manufacturing facility, to other customers or before use on site
Quality assurance/quality control (QA/QC) procedures applied	For projects using a mass balance approach (e.g., ISCC PLUS), scales must be calibrated according to the equipment manufacturer's specifications or at least every three years.

[53] For example, if the total mass of depolymerized plastics is 100 tonnes, which is fed into a steam cracker, and 50 percent of the steam cracker output is used as raw material to produce polymers, then the mass used for plastic production will be equal to 100 tonnes × 50 percent = 50 tonnes. The mass fraction (MF) = 50 / 100 = 0.5.

Purpose	Calculation of baseline recycled plastic waste Calculation of project recycled plastic waste
Comments	While projects may use a mass balance approach (e.g., ISCC PLUS), some mass balance approaches allow for a greater percentage of feedstock allocation than that which occurs in practice. The approach in this methodology requires projects to calculate the MF using the actual mass used for plastic production.

Table 9: End destination of non-recycled plastic waste

Data/Parameter	End destination of non-recycled plastic waste End destination of non-plastic waste from recycling facility
Unit	-
Description	End destination of plastic waste that enters the project recycling facility and is not recycled or is lost during the recycling process End destination of waste (other than non-recycled plastic) produced by the recycling activities of the facility. This includes any waste segregated at the sorting stage that is not used as an input to the recycling activity (if sorting is within the recycling facility) and any waste coming out of the recycling process.
Equation	-
Source of data	Third-party evidence (e.g., receipts, contractual agreements)
Description of measurement methods and procedures applied	-
Frequency of monitoring/recording	Yearly proof required, or where the end destination changes
Quality assurance/quality control (QA/QC) procedures applied	~~-~~If waste contains hazardous substances, it must be managed through environmentally and socially appropriate technologies and processes in accordance with the relevant national, regional or local regulations and guidelines.

Purpose	Monitoring ~~of~~for compliance with Applicability Condition ~~7~~11 in Section 4
Comments	-End destination and/or management of hazardous waste streams, where possible, may be disclosed using *ISO 14001:2015 – Environmental management systems – Requirements with guidance for use* or other relevant standards or certification schemes.

9.3 Description of Monitoring Plan

The project proponent ~~shall~~must establish and apply quality management procedures to manage data and information. Written procedures (e.g., standard operating procedures, SOPs) ~~shall~~must be established for each measurement task, outlining responsibility, timing and record location requirements. The greater the rigor of the management system for the data, the easier it will be to conduct an audit for the project.

Record-keeping practices ~~shall~~must include the following procedures:

- During the crediting period, all parameters listed in Section 9.2 ~~shall~~must be monitored and recorded.
- The amount of each material type recycled by the project ~~shall~~must be measured with weighing scales before being dispatched to the next stage and before being used for any manufacture of products within the recycling facility. The amount of plastic waste recycled ~~shall~~must be cross-checked by:
    - Comparison against the maximum recycling capacity of the facility; and
    - Sales receipts to final buyer or other equivalent third-party evidence.

  In case of inconsistencies, a conservative approach to correction ~~shall~~must be taken.
- The project proponent ~~shall~~must establish, maintain and apply a monitoring plan and information system that includes criteria and procedures for obtaining, recording, compiling and analyzing the data, parameters and other information important for quantifying and reporting the amount of recycled plastic waste in the project and baseline scenarios.
- Monitoring procedures ~~shall~~must address the following:
    - Data and information to be reported;
    - Data units;
    - Data sources;
    - Monitoring methods (e.g., estimation, modeling, measurement and calculation);
    - Monitoring equipment;
    - Monitoring frequencies;
    - QA/QC procedures; and
    - Data management system, including the location, backup, and retention of stored data.

- Monitoring and weighing equipment ~~shall~~must be maintained and calibrated according to current good practice (e.g., relevant industry standards or manufacturer specifications) or at least every three years.
- Monitoring personnel ~~shall~~must be trained to ensure that monitoring requirements are carried out in accordance with the monitoring plan.
- Monitoring roles and responsibilities ~~shall~~must be clearly defined in the project description, and training requirements addressed.
- All data collected as part of monitoring ~~shall~~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.
- QA/QC procedures ~~shall~~must be applied to increase confidence that all measurements and calculations have been made correctly. These include, but are not limited to:
    - Data gathering, input and handling measures;
    - Checking input data for typical errors, including inconsistent physical units and unit conversion errors;
    - Detecting typographical errors caused by data transcription from one document to another, and missing data for specific time periods or physical units;
    - Checking input time series data for large unexpected variations (e.g., orders of magnitude) that could indicate input errors;
    - Use of version control for all electronic files to ensure consistency;
    - Physical protection of monitoring equipment (e.g., sealed meters and data loggers);
    - Physical protection of records of monitored data (e.g., hard copy and electronic records);
    - Checking and documenting input data units; and
    - Documentation of all sources of data and assumptions.

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APPENDIX I: DOCUMENT HISTORY

Version	Date	Comment
v1.0	10 Feb 2021	Initial version (new methodology) released under Plastic Program Version 1.
v1.1	30 June 2022	Updates expand the scope of the methodology to include criteria and procedures applicable to chemical recycling technologies. Effective dates and deadlines: • v1.0 of the methodology was put on hold on 30 June 2022. • Projects using v1.0 of the methodology must request listing on the Verra Registry on or before 30 September 2022. • Projects using v1.0 of the methodology must complete validation and request registration with the Plastic Program on or before 31 December 2022. • Projects validated against v1.0 of the methodology must update to the latest version of the methodology (either v1.1 or any relevant subsequent version) at crediting period renewal.