Circular Economy Methodology for Encouraging Plastic Recycling

M/CE-R01

Global ZERO WASTE FOUNDATION

CERCARBONO Certified Carbon Standard

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Abbreviations and acronyms

CE	Circular Economy
CPC	Circular Plastic Credit
CDW	Construction and demolition waste
HDPE (2)	High density polyethylene (2)
IPCC	Intergovernmental Panel on Climate Change
ISO	International Organization for Standardization
LDPE (4)	Low Density Polyethylene (4)
MRV	Monitoring, reporting, and verification
MSW	Municipal solid waste
PCEM	Programme or Project on Circular Economy Materials
PCL	Polycaprolactone
PDD	Project Description Document
PET (or PETE) (1)	Polyethylene terephthalate (1)
PP (5)	Polypropylene (5)
PS (6)	Polystyrene (6)
PVC (3)	Polyvinyl chloride (3)
RP	Rethink Plastic
SDGs	Sustainable Development Goals
UNFCCC	United Nations Framework Convention on Climate Change
VPCE	Voluntary Programme on Circular Economy
VVB	Validation and Verification Body
ZWE	Zero Waste Europe

Terms and definitions

The terms and definitions relevant to this methodology are the ones presented in the document ***Terms and Definitions of the Voluntary Programme on Circular Economy***, available at www.cercarbono.com. Furthermore, the following definitions apply:

Accreditation period: the time span in which verified and certified plastic waste recycled by the project can result in issuance as Circular Plastic Credits (CPCs). The length that applies to an accreditation period for a Programme or Project on Circular Economy Materials (PCEM) and whether the crediting period is renewable or fixed, is determined in accordance with the Voluntary Programme on Circular Economy (VPCE). (Adapted from UNFCCC Glossary (2022) and VPCE (2023)).

Chemical recycling: chemical process in which waste is converted into its original components, allowing it to become a quality feedstock for the re-production of such material. (VPCE, 2023).

Debundled: a large-scale PCEM that has been separated into smaller, distinct parts. (Adapted from UNFCCC Glossary, 2022).

Dumpsites: a place where rubbish is left, for example on open ground outside a town.

Formal waste sector: solid waste management activities planned, sponsored, financed, carried out or regulated and/or recognized by the local authorities or their agents, usually through contracts, licenses, or concessions. (UNFCCC, AMS-III.AJ., 2022).

Informal waste sector: individuals or a group of individuals who are involved in waste management activities but are not formally registered or formally responsible for providing the waste management services. Newly established formalized organizations of such individuals can also be considered as the informal sector for the purpose of this methodology. (Adapted from UNFCCC, AMS-III.AJ., 2022).

Mechanical recycling: a physical-mechanical process by which household, industrial, commercial, official, and agricultural waste is recovered, allowing it to be used to produce new products. (VPCE, 2023).

Open burning: open burning of waste can be defined as the combustion of unwanted combustible materials such as paper, wood, plastics, textiles, rubber, waste oils and other debris in nature (open-air) or in open dumps, where smoke

and other emissions are released directly into the air without passing through a chimney or stack. Open burning can also include incineration devices that do not control the combustion air to maintain an adequate temperature and do not provide sufficient residence time for complete combustion. This waste management practice is used in many developing countries while in developed countries open burning of waste may either be strictly regulated, or otherwise occur more frequently in rural areas than in urban areas. (IPCC, 2006).

Plastic credits ownership: (from now on CPC ownership) the legal right of possession of the circular plastic credits generated from the project. This ownership could be agreed between the different project actors.

Plastic waste collection (from now and forward, collection): logistical process of moving plastics waste from its source to a place where it can be recovered following the procedures of this methodology. (Based on the definition of "collection" in ISO 472:2013).

Processing/Manufacturing facility: includes industrial processes to transform recyclable materials obtained from the recycling facility into intermediate or finished products that is plastic resin. (Adapted from UNFCCC, AMS-III.AJ., 2022).

Project activity: an operation or action that aims to reduce plastic waste from sources. (Adapted from UNFCCC Glossary, 2022).

Project actors: the different participants of a project.

Project ownership: legal right to control and operate the programme or project activity.

Project proponent: individuals, organizations, or a combination of them that oversee the whole control and commitments for the project and who can demonstrate the ownership of the project.

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

Recycling facility: facility where the recyclable fraction of the collected municipal solid waste is sorted, classified, and prepared into marketable commodities for processing/manufacturing in single or multiple locations. In the case of plastics recycling, washing with hot water to clean the plastic to free it from extraneous materials is an essential part of this activity. (UNFCCC, AMS-III.AJ., 2022).

Retrofit: or modification is an investment to repair or modify existing operating plants/units, with the purpose to increase the efficiency, performance, or capacity of the plants/units, without adding new plants/units. A retrofit restores the installed capacity to or above its original level. Retrofits shall only include measures that involve capital investments and not regular maintenance or housekeeping measures. (Adapted from UNFCCC, AMS-I.D., 2014).

Sanitary landfill: well-engineered facilities designed to receive specific kinds of waste, including municipal solid waste (MSW), construction and demolition waste (CDW) and hazardous waste. Landfill facilities must be designed to protect the environment from contaminants, which may be present in the solid waste disposed in the unit. (EPA, 2023).

Stakeholders: individuals, groups, or communities, affected, or likely to be affected, by the project activity or programme activity, from its planning to its execution. (UNFCCC Glossary, 2022).

1 Introduction

Plastic waste has become a growing concern all over the world, on average, 8,300 million tons of plastic have been generated, out of which 6,300 million tons has been discarded as waste (Walker, 2021). Globally, less than 10 % is recycled, 79 % is directly discarded in aquatic and terrestrial lands. Over 23 million tons of plastic wastes have entered the oceans (Borrelle *et al*., 2020), increasing the mortality of marine species, due to entanglement in floating plastic debris or ingestion of plastic particles (OECD, 2022). But plastic litter also has substantial economic costs due to negative impacts on tourism and fishing (Krelling, Williams, and Turra, 2017). Human health concerns have also emerged over certain plastic additives and substances being inhaled or ingested in food (OECD, 2022).

Great majority of plastic waste is not biodegradable, so it tends to accumulate at landfills and the environment when it is not properly managed (Geyer, 2017). In addition, 4 % of petrol and gas extracted are used as raw material for virgin plastic production, and between 3 and 4 % for generating energy for its manufacture (Hopewell *et al*., 2009). Because of that, plastic waste use with minimum environmental externalities plays a crucial role in building up the target of Sustainable Development Goals (SDGs) (Pujara *et al*., 2019; WRAP, 2023). Circular economy (CE) closes the loop of plastic waste and convert plastic waste into a sustainable secondary source (Chand *et al*., 2021; Pathak and Srivastava, 2021), reducing 80 % of end-of-life plastic disposal by 2050 compared to today (Plastics Europe, 2023).

Converting waste into wealth has gained significance and can be perceived as good health and well-being (SDG 3) of the communities, sustainable consumption, and production (SDG 12) of products, decent and sustainable livelihood in terms of pollution free physical environment (SDG 7, 11, 13, 14, and 15), economic conditions (SDG 1, 2, 5, and 8) and social equity (SDG 4, 5, 10) (Ajwani-Ramchandani and Bhattacharya, 2022).

Up till now, a significant share of the plastic waste collection and recycling has been carried out by the informal sector, making official and accurate information exceptionally scarce, mainly in developing countries. The main purpose of this methodology is to increase and empower plastic recycling projects in the formal and specially the informal sector, by fostering the formalization of projects and enhancing SDG targets achievement.

To promote the increase on this type of projects, it is of upmost importance the generation of additional financing that can be obtained through plastic credits, which guarantee its profitability and sustainability, as long as the project meets the

applicability and additionality criteria defined under this methodology. Circular plastic credits can be the final missing piece of the puzzle picturing a circular economy, especially as an interim measure and later as a component to be integrated into existing and upcoming extended producer responsibility (EPR) schemes. The credit system could serve as an offsetting mechanism to recover an equivalent or higher amount of plastics to be produced by the purchasing responsible manufacturer (Lee, 2021). A circular plastic credit (CPC), as it was already defined at the Voluntary Program on Circular Economy (VPCE), represents one metric tonne of plastic that would not otherwise been reduced or recirculated from the environment, in the case of the present methodology, recycled.

It is important to highlight that this methodology will not only be a gamechanger for the plastic recycling and collection industry and the environment, but also for empowering actors and communities involved in this sector. Simultaneously, thanks to this methodology, more accurate, traceable, and verifiable information will be available for decision makers and civil society, bringing opportunities to remove more plastic waste from the environment and dignify the jobs of millions of people all over the world.

2 Principles

PCEMs using this methodology shall comply and refer the relevant principles established in the current version of ***Global Zero Waste and Cercarbono's Protocol for Voluntary Certification of Circular Economy***, available at www.cercarbono.com.

3 Purpose and scope

The main purpose of this methodology is to increase and empower plastic recycling projects throughout circular plastic credits (CPCs) generation in formal and especially informal sectors, since the latter is said to be responsible for 58 % of all the plastic waste collected and recycled globally (Lau *et al*., 2020). Such projects may include one or more of the plastic types described in the ***Global Zero Waste and Cercarbono's Protocol for Voluntary Certification of Circular Economy***.

The methodology comprises plastic recycling activities which divert plastic waste from the environment, while reintroducing the material into the value chain as feedstock for industry or manufacturing of new products. Such activities include the following types:

Type 1. Development of a new recycling facility.

- **Option A.** Formal sector (according to definition of formal sector stated at ***Terms and definitions*** section): the project ownership, construction and operation of the new recycling facility are done by the formal sector. In case it receives plastic waste from an external supplier (formal or informal), it is ensured that no unfair labour practices are taking place in the collection or sorting processes done before reaching the recycling facility. Recycling facility can ask for CPCs within the retroactivity period defined by the VPCE.
- **Option B.** Informal sector (according to definition of informal sector stated at ***Terms and definitions*** section): projects that have started their operations informally within the retroactivity period defined by the VPCE may be registered as new projects. However, at the time of registration, the project must demonstrate compliance with all applicable regulations or being involved in a formalization process with the correspondent authorities. Only the plastic recycled under these conditions is accounted for CPCs. Furthermore, all recycled plastic must demonstrate compliance with the monitoring parameters requested in this methodology.

Type 2. Capacity increase in an existing facility.

It involves projects that introduce a new equipment to an existing facility or improve the existing equipment or substitutes it in a way that leads to an increase on capacity to recycle plastic waste.

- **Option A.** Formal sector: the project ownership and operation of the existing recycling facility are within the formal sector. Information of the two years before the capacity increase is available. In case it receives plastic waste from an

external supplier (formal or informal), it is ensured that no unfair labour practices are taking place in the collection or sorting processes done before reaching the recycling facility. Recycling facility can ask for CPCs for this capacity Increase whenever it has occurred within the retroactivity period defined by the VPCE.

- **Option B.** Informal sector: projects that have introduced an improvement or have added new equipment to the existing recycling facility while being informal, may be registered if the capacity increase has been carried out within the retroactivity period defined by the VPCE. However, at the time of registration, the project must demonstrate compliance with all applicable regulations or being involved in a formalization process with the correspondent authorities. Only the plastic recycled under these conditions is accounted for CPCs. Furthermore, all recycled plastic must demonstrate compliance with the monitoring parameters requested in this methodology.

Type 3. Retrofit of a recycling facility.

It refers to an existing facility that has stopped its operation in absence of the CPCs. In this case, the necessity of additional income from the CPCs should be demonstrated.

- **Option A.** Formal sector: the project ownership, retrofit and operation done by the formal sector. In case it receives plastic waste from an external supplier (formal or informal), it is ensured that no unfair labour practices are taking place in the collection or sorting processes done before reaching the recycling facility.
- **Option B.** Informal sector: projects that have done the retrofit informally within the retroactivity period defined by the VPCE may be registered as a retrofit project. However, at the time of registration, the project must demonstrate compliance with all applicable regulations or being involved in a formalization process with the correspondent authorities. Only the plastic recycled under these conditions is accounted for CPCs. Furthermore, all recycled plastic must demonstrate compliance with the monitoring parameters requested in this methodology.

Type 4. Increase of collection or sorting capacity for existing recycling facilities.

Contemplates projects within the formal sector that increase their recycling throughout improving collection and/or sorting by means of different actions; such as paying better price to collectors, improving collectors' conditions, stablishing collection, or sorting points at landfills, improving sorting at the recycling plant thanks to an increase of hired people and/or improving on sorting equipment, or by integrating collection activities into the responsibilities of the company when they

were not integrated, etc. In any case, baseline information regarding the material collected and entering in the process of the two years before increasing the collection capacity, should be available.

Figure 1. Project type configuration.

3.1 Applicability

The methodology is applicable to projects that meet the following general conditions:

General applicability conditions:

1. The plastic waste entering in the recycling process is collected or diverted from one or more of the following sources:
   - Environment (land/affluent/ocean).
   - Dumpsites.
   - Sanitary landfills.
   - Diverted from open burning.
   - Diverted from incineration with or without energy recovery.
   - Urban (recycling routes and collection points).
   - Directly diverted from post-consumption sources (e.g., agricultural, industrial, households, commercial entities, etc.).
2. Plastic waste recycled in the project activity corresponds to any of the plastic types described in the VPCE's Protocol. These plastics corresponds to: PET, HDPE, PVC, LDPE, PP, PS, and other types.
3. The recycling activity is developed through either mechanical or chemical processes in line with the section ***Terms and definitions***. Projects can also carry out both processes within the same PCEM.
4. It is possible to provide a detailed description of the upstream collection process, ensuring that it does not involve undignified or unhealthy labour practices.
5. The project activity can demonstrate compliance with local and national applicable legislations.
6. Environmental and social safeguards must be ensured.
7. It is possible to accurately estimate the plastic waste recycled (on a dry basis), by the project activity, either by direct monitoring, for mechanical recycling, or by using the mass balance approach, for chemical recycling.
8. For a formal activity Type 2, monitoring information of at least 2 years before the implementation of the project must be available.
9. For activity Type 4, it is possible to demonstrate how the recycling facility has not been able to fill their installed capacity during the last 2 years prior to the implementation of the project activity.
10. Recycled plastic is sold to an identifiable facility or retailer, ensuring it's end use as feedstock for industry or manufacturing of plastic recycled products. Fuel production is not considered a proper end use for the applicability of this methodology.

11. Non-recycled plastic waste at the facility is managed according to applicable legislation and it is possible to ensured that it does not end in the environment or dumpsites.
12. If the Plastic Waste Recycled is sold to an identified consumer group, the project owner and the Processing/Manufacturing facility are bound by a contract that allows the project owner to monitor the use of the Plastic Waste Recycled and that states that the manufacturer shall not claim CPC resulting from its consumption.
13. Plastic recycling facility does not compete or divert plastic waste from other recycling facility[1].
14. In case of composite materials, this methodology will apply only when plastic materials can be completely separated.

Special applicability conditions:

In addition to the general applicability conditions mentioned above, the following conditions apply to any PCEM that involves one or more of the following cases:

Case A: Chemical recycling.

A.1. Only for materials that cannot be recycled in any other way or situations where mechanical recycling is not an option.

Case B: Projects including imported plastic waste.

B.1. Transboundary movements consider local legislation related to transboundary hazardous waste, as well as the Basel Convention.

Case C: Projects involving collection activities.

C.1. Job creation prioritize local population, promoting gender equality.

C.2. Projects improve labour conditions of collectors in comparison with the baseline scenario.

C.3. CPCs ownership agreement: there must be a written agreement between the collectors and the recycler stablishing the ownership of the issued CPCs.

Case D: Previous informal recycling facility.

D.1. It is possible to demonstrate the date when the investment was carried out.

[1] This should be verified VVB throughout support information, interviews, information gathered during public consultation of the PCEM, etc.

D.2. The project activity can demonstrate that even though it began as an informal activity, the formalization process has been initiated with the corresponding authorities.

D.3. From the moment when the formalization process has started, it is ensured that no unfair labour practices are taking place in the collection or sorting processes (formal or informal) taking place before reaching the recycling facility.

3.2 Project boundary

Project boundary goes from the plastic waste source until its final use as raw material, passing through its collection, sorting, and recycling, as explained below:

- Source: site in which the plastic waste is generated.
- Waste collection sites.
- Gathering and sorting facility.
- Plastic waste recycling facility.
- Identifiable plant or retailer, where the recycled plastic is use as feedstock for industry or manufacturing of new products.

Figure 2. Project boundary.

3.3 Scale

Recycling project activities are segmented into two groups according to the installed capacity of the facility:

Small-scale: PCEMs with a total installed capacity up to 1000 t/y in their recycling facility.

Large-scale: PCEMs with a total installed capacity higher than 1000 t/y in their recycling facility.

3.4 Debundling

A proposed small-scale project activity is considered a debundled component of a large-scale project activity if there is a large-scale PCEM registered or in formulation phase, that meets the following conditions:

a) They share the same project participants.
b) Both projects have the same project category and technology/measures.
c) The starting date of both PCEMs are within 2 years of each other.
d) There is a recycling facility within 1 km of the small-scale PCEM at its closest point.
e) Project whose source of plastic waste is being diverted from other recycling facilities.

In case the project meets these conditions, the PCEM will have to be consider as a large-scale project. However, if the proposed small-scale project activity is deemed to be a debundled component, but the total size of such activity combined with the previous registered small-scale projects do not exceed the limits (t/year) for small-scale PCEMs (see **Section 3.3**), then the projects are still small-scale.

3.5 Additionality

All PCEMs seeking to apply this methodology must demonstrate additionality. This means that in the absence of the proposed PCEM, the amount of plastic waste re-cycled by it, wouldn't have been removed from the environment, nor reintroduced into the value chain. This analysis should take place, considering each plastic type included in the PCEM. To demonstrate additionality, the following steps should be followed according to flowchart in **Figure 3**.

Step 1: Additionality over mandatory laws and regulations.

All projects must demonstrate that activities taking place in the PCEM go beyond compliance of mandatory regulations. Thus, a local and national regulatory framework must be provided and analysed for determining if the project is in fact additional over mandatory laws and regulations.

If an alternative does not exceed certain mandatory legislation, the project participant can demonstrate that, based on an examination of current practice in the country or region in which the law or regulation applies, those applicable legal or regulatory requirements are systematically not enforced and that noncompliance with those requirements is widespread in the country. (Adapted from UNFCCC – CDM, Tool 01, 2012).

Baseline scenario must consider the mandatory requirement. In cases where the project exceeds the mandatory legislation only the CPCs generated over the mandatory requirement are considered additional.

Outcome of Step 1: the proposed PCEM can demonstrate that its activity goes beyond mandatory laws and regulations, or legal practice in the country or region are not systematically enforced and that noncompliance with those requirements is widespread in the country or region, then proceed with Step 2. If nothing described above can be demonstrated, then the project is not additional.

Step 2 (optional): First-of-its-kind project activities.

This step applies only when it's possible to demonstrate that the project utilises completely new technologies, measures, or processes in the country/region where the PCEM takes place. This demonstration must be showed in the Project Description Document (PDD). If the project participants opt to limit the applicable geographical area to a specific geographical area (such as province, region, etc.) within the host country, then they shall provide justification on the essential distinction between the identified specific geographical area and rest of the host country.

Outcome of Step 2: if the proposed PCEM can demonstrate that it's a First-of-its-kind project, then the project is additional. Otherwise, proceed to Step 3.

Step 3: Positive list.

Proposed PCEM is considered automatically additional when it meets one or more of the following conditions:

- Small-scale projects, according to the scale definition in **Section 3.3**.
- Projects whose plastic waste collected comes from rural areas of a non-high-income economy[2]. The concept of rural areas corresponds to each countries' definition of "rural area"[3].

[2] According to World Bank Country and Lending Groups. https://datahelpdesk.worldbank.org/knowledge-base/articles/906519.

[3] An administrative unit with a population density of less than 300 inhabitants per square kilometre (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 in the host country.

- Projects being developed in; or collecting plastic waste from Least Developed Countries (LDC[4]) and Small Islands Developing States (SIDS[5]).

Outcome of Step 3: if the proposed PCEM can demonstrate that it meets any of the options mentioned in Step 3, it is additional and there's no need to proceed to Step 4. If not, please proceed to Step 4.

Step 4: Common practice.

Proposed PCEM is considered common practice when the amount of recycled plastic is higher than a specific percentage of the plastic waste generated in the region or country where the recycling facility is located.

$$\frac{PR}{PW}\ x\ 100 > 9\%^{6} \qquad \textbf{Equation 1}$$

Where:

PW = Total weight of plastic waste generated in the country or region where the recycling facility is located.

PR = Total weight of plastic mechanically and chemically recycled in the country or region where the recycling facility is located.

Plastic Waste generation and effective plastic recycling in the country or region shall be rated based on public information provided by the local or national government, scientific publications, or third-party recognised studies.

To demonstrate that the proposed PCEM is not common practice the most recent statistics on plastic waste generation and recycled plastic available from credible sources should be applied. This information should be corroborated by the VVB at validation stage.

Outcome of Step 4: if the proposed PCEM can demonstrate that the percent of recycled plastic in the area is lower than proposed recycling rate in the country or region, then, it is additional and there's no need to proceed to Step 5. If not, please, proceed to Step 5.

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[4] 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.

[5] 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.

[6] This value or a percentage of plastic recycled per region must be determined according to credible sources from each region/country. The value of 9 % is based on OECD, 2022.

Step 5: Investment analysis.

Financial additionality must be demonstrated applying the most recent version of [UNFCCC - CDM *Tool 27 Investment Analysis*](#).

Outcome Step 5: if the proposed PCEM can demonstrate financial additionality, then the PCEM is additional. Otherwise, the project can't apply for CPCs.

Figure 3. Decision tree for demonstrating additionality[7].

[7] Adapted from Tool 01 of CDM using additionality steps of this methodology.

4 Contributions to the UN Sustainable Development Goals

In the framework of VPCE, PCEMs shall report their contributions to SDGs by means of ***Tool to Report Contributions of Circular Economy Initiatives to the Sustainable Development Goals***, available at www.cercarbono.com. Assessment of application of such tool will be part of the verification process. The rubric of the SDG tool shall be duly signed by the VVB in charge of the verification event.

PCEMs adequately implementing Cercarbono's SDGs tool shall be awarded a differentiation seal, shown on the retirement certificate and in EcoRegistry platform.

5 Climate change and circular economy

Circular economy, and plastic recycling contribute to displace the production of virgin materials in dedicated facilities, thereby they might result in avoidance of energy use and GHG emissions as far as the net reduction from producing recycled plastic will overcome emissions from the process. Project proponent can use the following guide to report the project's contributions to SDG 13. Climate action.

Calculation guide for GHG emission

GHG emissions from plastic waste recycling can be calculated using standard emissions factors from reliable sources, such as Zero Waste Europe (ZWE) and the Rethink Plastic (RP) alliance report[8].

This study shows that chemical and mechanical recycling generates GHG emissions, and that recycled plastic replaces primary plastics from fossil raw materials, thus avoiding the production of new primary plastic.

Net emissions results from the difference between emission and avoidance. A negative value means emission reductions and a positive value means burdens emissions increase.

Net emission calculation will result from the net emissions from one or both processes whether mechanical and/or chemical recycling are applied:

$$NE_{rec} = (PR_{y,mec} - BR_{y,mec}) \times EF_{mrec} + (PR_{y,chem} - BR_{y,chem}) \times EF_{chrec}$$

NE_{rec} = Net emissions from recycling (t CO_2e).

$PR_{y,mec}$ = Total weight of plastic mechanically recycled in the project scenario, in year “y” (t/y).

$BR_{y,mec}$ = Total weight of plastic mechanically recycled in the baseline scenario, in year “y” (t/y).

EF_{mrec} = CO_2 net emission factor of mechanical recycling of plastic material (t CO_2e/t).

$PR_{y,chem}$ = Total weight of plastic chemically recycled in the project scenario, in year “y” (t/y).

$BR_{y,chem}$ = Total weight of plastic chemically recycled in the baseline scenario, in year “y” (t/y).

[8] Möck *et al.*, (2022). Climate impact of pyrolysis of waste plastic packaging in comparison with reuse and mechanical recycling - https://zerowasteeurope.eu/wp-content/uploads/2022/09/zwe_2022_report_climat_impact__pyrolysis_plastic_packaging.pdf.

EF_{chrec} = CO_2 net emission factor of chemical recycling of plastic material (t CO_2e/t).

GHG emission factors from the study of ZWE and RP are presented in following table. However, project developer may choose to apply another emission factors as far as they come from a credible source.

Table 1. Net emission factors[9].

	Net t CO_2e per plastic tonne
EF_{mrec}	-1.52
EF_{chrec}	0.62

It is important to clarify that the emission factor indicates net emissions, which means that, when the factor is negative, avoided emissions coming from virgin plastic by recycled plastic substitution are higher than process emissions.

On the other hand, a positive factor indicates that the chemical recycling process generates more emissions than those avoided with virgin plastic by recycled plastic substitution due to the high energetic consumption of the chemical recycling process.

[9] Möck *et al.*, (2022). Climate impact of pyrolysis of waste plastic packaging in comparison with reuse and mechanical recycling - https://zerowasteeurope.eu/wp-content/uploads/2022/09/zwe_2022_report_climat_impact__pyrolysis_plastic_packaging.pdf.

6 Baseline scenarios

6.1 Baseline scenarios selection

Consist of the most probable scenarios in absence of the proposed PCEM. Thus, for plastic recycling, the baseline scenarios correspond to the amount of plastic waste that would have been recycled in the project area.

Table 2. Baseline scenarios.

Project activity type		Situation	Baseline scenarios (BR)
1	Development of a new recycling facility.	Formal	No recycling activity would have taken place in absence of the project. Therefore, BR = 0 or mandatory legislation, if any.
		Informal	
2	Install capacity increase of an existing facility.	Formal	Continuation of the existing facility. Therefore, BR = Average of the plastic waste recycled in the last 2 years.
		Informal	Continuation of the existing facility. Therefore, BR = Average of the plastic waste recycled in the last 2 years or installed capacity of the existing plant.
3	Retrofit of a recycling facility.	Formal	No recycling activity would have taken place in absence of the project. Therefore, BR = 0 or mandatory legislation, if any.
		Informal	
4	Increase of collection capacity for existing recycling facilities.	Formal	Continuation of the existing collection capacity. Therefore, BR = Average of the plastic waste recycled in the last 2 years.

6.2 Calculation of plastic waste in the baseline scenario

The plastic waste recycled in the baseline scenario, depends on the type of project activity as shown in **Section 6.1**.

In places where there is mandatory legislation in force, the plastic waste recycled in the baseline scenario must be adjusted according to the law.

For mechanical recycling:

$$BR_{y,mec} = \sum_{i=1}^{n} BR_{i,y,mec}$$ **Equation 2**

Where:

$BR_{y,mec}$ = Total weight of mechanical recycled plastic in the baseline scenario in year "y" (t/y).

$BR_{i,y,mec}$ = Weight of baseline mechanical recycled plastic type "i" in the baseline scenario in year "y" (t/y).

Chemical recycling:

$$BR_{y,chem} = \sum_{i=1}^{n} BR_{i,y,chem}$$ **Equation 3**

Where:

$BR_{y,chem}$ = Total weight of chemical recycled plastic in the baseline scenario in year "y" (t/y).

$BR_{i,y,chem}$ = Weight of baseline chemical recycled plastic type "i" in year "y" (t/y).

The total amount of plastic waste recycled (mechanical and chemical) in the baseline scenario, is calculated as follows:

$$BR_y = BR_{y,mec} + BR_{y,chem}$$ **Equation 4**

Where:

BR_y = Total weight of baseline chemical and/or mechanical recycled plastic in year "y" (t/y).

$BR_{y,mec}$ = Total weight of baseline mechanical recycled plastic in year "y" (t/y).

$BR_{y,chem}$ = Total weight of baseline chemical recycled plastic in year "y" (t/y).

Baseline scenario must be re-assessed at the renewal of the crediting period. If new mandatory legislation is introduced or the existing legislation is replaced the baseline scenario must consider the mandatory requirement.

7 Project scenario

7.1 Calculation of plastic recycled

Plastic waste must be properly separated per type of plastic and the project owner must ensure that the different types of plastics can be independently measured.

Mechanical recycling:

$$PR_{y,mec} = \sum_{i=1}^{n} PR_{i,y,mec}$$ **Equation 5**

Where:

$PR_{y,mec}$ = Total weight of plastic mechanically recycled in the project scenario, in year "y" (t/y).

$PR_{i,y,mec}$ = Weight of project mechanical recycled plastic type "i" in year "y" (t/y).

For *ex-ante* estimation of plastic mechanically recycled:

$$PR_{y,mec} = \sum_{i=1}^{n} PW_{i,y,mec} - L_{i,y,mec}$$

Where:

$PW_{i,y,mec}$ = Weight of plastic waste type "i" entering the mechanical recycling facility, in the project scenario during the year "y" (t/y).

$L_{i,y,mec}$ = Weight of plastic type "i" leakage resulting from the sorting and recycling processes in year "y" (t/y).

Chemical recycling:

$$PR_{y,chem} = \sum_{i=1}^{n} PR_{i,y,chem}$$ **Equation 6**

Where:

$PR_{y,chem}$ = Total weight of plastic chemically recycled in the project scenario, in year "y" (t/y).

$PR_{i,y,chem}$ = Weight of project chemical recycled plastic type "i" in year "y" (t/y).

For *ex-ante* estimation of plastic chemically recycled:

$$PR_{y,chem} = \sum_{i=1}^{n} PW_{i,y,chem} - L_{i,y,chem}$$

Where:

$PW_{i,y,chem}$ = Weight of plastic waste type "i" entering the recycling facility, in the project scenario during the year "y" (t/y).

$L_{i,y,chem}$ = Weight of plastic type "i" leakage resulting from the sorting and recycling processes in year "y" (t/y).

The total amount of plastic waste recycled in the project scenario is calculated as follows:

$$PR_y = PR_{y,mec} + PR_{y,chem} \qquad \textbf{Equation 7}$$

Where:

PR_y = Total weight of project chemical and mechanical recycled plastic in year "y" (t/y).

$PR_{y,mec}$ = Total weight of plastic mechanically recycled in the project scenario, in year "y" (t/y).

$PR_{y,chem}$ = Total weight of plastic chemically recycled in the project scenario, in year "y" (t/y).

7.2 Leakage

Plastic leakage at the project process is indirectly monitored and it is accounted as the difference between the amount of plastic material that enter the recycling process and the amount of plastic material effectively recycled. Therefore, there must be at least two plastic weighed events, one at the facility input point and other at the final stage after plastic recycling.

Mechanical recycling:

$$L_{y,mec} = \sum_{i=1}^{n} (PW_{i,y,mec} - PR_{i,y,mec})$$ **Equation 8**

Where:

$L_{y,mec}$ = Total weight of plastic leakage resulting from the sorting and recycling processes in year "y" (t/y).

$PW_{i,y,mec}$ = Weight of plastic waste type "i" entering the mechanical recycling facility, in the project scenario during the year "y" (t/y).

$PR_{i,y,mec}$ = Weight of project mechanical recycled plastic type "i" in year "y" (t/y).

Chemical recycling:

$$L_{y,chem} = \sum_{i=1}^{n} (PW_{i,y,chem} - PR_{i,y,chem})$$ **Equation 9**

Where:

$L_{y,chem}$ = Total weight of plastic leakage resulting from the sorting and recycling processes in year "y" (t/y).

$PW_{i,y,chem}$ = Weight of plastic waste type "i" entering the chemical recycling facility, in the project scenario during the year "y" (t/y).

$PR_{i,y,chem}$ = Weight of project chemical recycled plastic type "i", in year "y" (t/y).

The total amount of plastic waste leakage in the project scenario is calculated as follows:

$$L_y = L_{y,mec} + L_{y,chem}$$ **Equation 10**

Where:

L_y = Total weight of project plastic leakage in year "y" (t/y).

$L_{y,mec}$ = Weight of project plastic leakage from mechanical recycling, in year "y" (t/y).

$L_{y,chem}$ = Weight of project plastic leakage from chemical recycling, in year "y" (t/y).

8 Net plastic waste recycled

$$CPC_y = PR_y - BR_y$$ **Equation 11**

Where:

CPC_y = Circular plastic credits or net plastic recycled in year "y" (t/y).

PR_y = Total weight of project chemical and mechanically recycled plastic in year "y" (t/y).

BR_y = Total weight of baseline chemical and mechanically recycled plastic in year "y" (t/y).

9 Project monitoring

Project owner must ensure that exist a proper monitoring plan of the process. This plan must monitor all the variables that must take part of the plastic recycling process, mainly the plastic waste mass flow between the different recycling processes.

9.1 Data and parameters not monitored

The following parameters must be known before project monitoring.

Data / Parameter	$BR_{i,y,mec}$
Unit	tonnes/year
Description	Total weight of baseline scenario mechanical recycled plastic type "i" in year "y".
Value	-
Source of data	Source of data depends on the project type. See **Section 6.1**. Baseline scenarios selection, **Table 2**. Baseline scenarios.
Purpose	Calculation of plastic waste in the baseline scenario.
Comments	

Data / Parameter	$BR_{i,y,chem}$
Unit	tonnes/year
Description	Total weight of baseline chemical recycled plastic type "i" in year "y".
Value	-
Source of data	Source of data depends on the type of project activity. See **Section 6.1**. Baseline scenarios selection, **Table 2**. Baseline scenarios.
Purpose	Calculation of plastic waste in the baseline scenario.
Comments	

9.2 Data and parameters monitored

The following parameters must be monitored and recorded during the whole accreditation period if possible[10].

Data / Parameter	$PW_{i,y,mec}$
Unit	tonnes/year
Description	Plastic waste type "i" entering the mechanical recycling facility, in the project scenario during the year "y".
Value	-
Source of data	Dry based, on-site measurement.
Purpose	Leakage calculation.
Measurement procedures (if any)	Measurement takes places as the plastic waste arrives to the facility and after it has been dried.
Monitoring frequency	Continuous.
QA/QC procedures	Scale must be calibrated according to the equipment manufacturer's specifications and local legislations or at least every three years.
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.

Data / Parameter	$PW_{i,y,chem}$
Unit	tonnes/year
Description	Plastic waste type "i" entering the chemical recycling facility, in the project scenario during the year "y".
Value	-
Source of data	Dry based, on-site measurement.
Purpose	Leakage calculation.
Measurement procedures (if any)	Measurement takes places as the plastic waste arrives to the facility and after it has been dried.
Monitoring	Continuous.

[10] Activities that started as informal projects may not have these parameters monitored during the retroactivity period. However, only the plastic recycled fulfilling the monitoring plan is accounted for CPCs.

frequency	
QA/QC procedures	Scale must be calibrated according to the equipment manufacturer's specifications and local legislations or at least every three years.
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.

Data / Parameter	$PR_{i,y,mec}$
Unit	tonnes/year
Description	Weight of mechanical recycled plastic waste type “i” in year “y”.
Value	-
Source of data	Dry based, on-site measurement.
Purpose	Calculation of plastic recycled.
Measurement procedures (if any)	Measurement takes places as the material has been transformed into feedstock for industry or manufacturing of new products.
Monitoring frequency	Continuous.
QA/QC procedures	Scale must be calibrated according to the equipment manufacturer's specifications and local legislations or at least every three years.
Comments	

Data / Parameter	$PR_{i,y,chem}$
Unit	tonnes/year
Description	Weight of chemical recycled plastic waste type “i” in year “y”.
Value	-
Source of data	Dry based, on-site measurement.
Purpose	Calculation of plastic recycled.
Measurement procedures (if any)	Measurement takes places as the material has been transformed into feedstock for industry or manufacturing of new products.
Monitoring	Continuous.

frequency	
QA/QC procedures	Scale must be calibrated according to the equipment manufacturer's specifications and local legislations or at least every three years.
Comments	

Data / Parameter	*Legal requirement*
Unit	NA
Description	List of applicable legislation related to plastic recycling.
Value	-
Source of data	National and regional law.
Purpose	Calculation of baseline scenario.
Measurement procedures (if any)	NA
Monitoring frequency	At the renewal of the crediting period.
QA/QC procedures	NA
Comments	

9.3 Description of the monitoring plan

Monitoring plan must be done according to section Monitoring the PCEM from the VPCE's Protocol. Furthermore, monitoring frequency and QA/QC procedures for each monitoring parameter must be followed according to this methodology.

Project proponent must apply a monitoring plan including the guidelines for data treatment to quantify and report the plastic waste being recycled in the project and baseline scenarios, furthermore it must comply with applicability conditions.

10 References

Articles

Ajwani-Ramchandani, R. and Bhattacharya, S. (2022). Moving towards a circular economy model through I4. 0 to accomplish the SDGs. *Cleaner and Responsible Consumption, 7, 100084*, 1-9. Available at: kutt.it/RmBRaa.

Bhatt, M. *et al*. (2021). Conversion of refuse derived fuel from municipal solid waste into valuable chemicals using advanced thermo-chemical process. *Journal of Cleaner Production, 329*, 129653. Available at: kutt.it/gyUK9g.

Borrelle, S. *et al*. (2020). Predicted growth in plastic waste exceeds efforts to mitigate plastic pollution. *Science, 369* (6510), 1515-1518. Available at: kutt.it/3MZKhH.

Chand, S. *et al*. (2021). Basic concepts, potentials, and challenges of urban mining. En: Pathak, P. and Rout, P. (Eds.), *Urban Mining for Waste Management and Resource Recovery*. Available at: kutt.it/k4IAX3.

Gall, M. *et al*. (2020). Building a circular plastics economy with informal waste pickers: Recyclate quality, business model, and societal impacts. *Resources, Conservation and Recycling, 156*, 104685. Available at: kutt.it/IF2BDR.

Genovese, A. *et al*. (2017). Sustainable supply chain management and the transition towards a circular economy: evidence and some applications. *Omega, 66*, 344-357. Available at: kutt.it/FNyjGD.

Govani, J. *et al*. (2020). Technological upgradation and advancement for treatment of plastic waste in developing countries. In: Hussain, C. (Ed.), *Handbook of Environmental Materials Management*. Available at: kutt.it/zi4gVI.

Hahladakis, J. and Lacovidou, E. (2018). Closing the loop on plastic packaging materials: what is quality and how does it affect their circularity? *Science of The Total Environment, 630*, 1394-1400. Available at: kutt.it/zd79xM.

Hopewell, J. *et al*. (2009). Plastics recycling: challenges and opportunities. *Philosophical Transactions of the Royal Society B, Biological Sciences, 364* (1526), 2115-2126. Available at: kutt.it/yseJ0T.

Kumar, A. *et al*. (2018). Estimation of the generation rate of different types of plastic wastes and possible revenue recovery from informal recycling. *Waste Management, 79*, 781-790. Available at: kutt.it/2V9sdb.

Krelling, A. *et al*. (2017). Differences in perception and reaction of tourist groups to beach marine debris that can influence a loss of tourism revenue in coastal areas. *Marine Policy*, *85*, 87-99. Available at: kutt.it/talgfl.

Lau, W. *et al*. (2020). Evaluating scenarios toward zero plastic pollution. Science, 369 (6510), 1455-1461. Available at: kutt.it/a90L6S.

Lee, M. (2021). Plastic pollution mitigation - net plastic circularity through a standardized credit system in Asia. *Ocean & Coastal Management*, *210*, 105733. Available at: kutt.it/OpGHm9.

Möck, A. *et al*. (2022). Climate impact of pyrolysis of waste plastic packaging in comparison with reuse and mechanical recycling. Available at: utt.it/IG4NFJ.

OECD. (2022), Global Plastics Outlook: Economic Drivers, Environmental Impacts and Policy Options. Available at: kutt.it/are31k.

Pathak, P. and Srivastava, R. (Eds.) (2021). Alternate energy resources: a way to sustainable modern society. Available at: kutt.it/Ouy3dV.

Pujara, Y. *et al*. (2019). Review on Indian Municipal Solid Waste Management practices for reduction of environmental impacts to achieve sustainable developmentgoals. *Journal of Environmental Management*, *248*, 109238. Available at: kutt.it/QrYiX1.

Ragaert, K. *et al*. (2017). Mechanical and chemical recycling of solid plastic waste. *Waste Management*, *69*, 24-58. Available at: kutt.it/YF5Zkc.

Tejaswini, M. *et al*. (2022). A comprehensive review on integrative approach for sustainable management of plastic waste and its associated externalities. *Science of The Total Environment*, *825*, 153973. Available at: kutt.it/uBw7Yj.

Walker, T. (2021). (Micro)plastics and the UN Sustainable Development Goals. *Current Opinion in Green and Sustainable Chemistry*, *30*, 100497. Available at: kutt.it/KdRnod.

Normatives or standards

Global Zero Waste and Cercarbono. (2023a). *Terms and Definitions of the Voluntary Programme on Circular Economy*. Version 1.0. Available at: www.cercarbono.com.

Global Zero Waste and Cercarbono. (2023b). *Global Zero Waste and Cercarbono's Protocol for Voluntary Certification of Circular Economy*. Version 1.1. Available at: www.cercarbono.com.

Global Zero Waste and Cercarbono. (2023c). *Tool to Report Contributions of Circular Economy Initiatives to the Sustainable Development Goals*. Version 1.1. Available at: www.cercarbono.com.

IPCC. (2006). *2006 IPCC Guidelines for National Greenhouse Gas Inventories*. Available at: kutt.it/90Wbz3.

ISO/IEC 472:2013. *Plastics - Vocabulary*. Available at: kutt.it/B5EeMJ.

UNFCCC. (2012). *Tool 01 Methodological tool: Tool for the demonstration and assessment of additionality*. Version 07. Available at: kutt.it/CmirIE.

UNFCCC. (2014). AMS-I.D.: *Grid connected renewable electricity generation*. Version 18.0. Available at: kutt.it/GAXZ24.

UNFCCC. (2022). *AMS-III.AJ.: Recovery and recycling of materials from solid wastes*. Version 9.0. Available at: kutt.it/xZki09.

UNFCCC. (2022). *Tool 27 Methodological tool: Investment analysis*. Version 12.0. Available at: kutt.it/qb430g.

UNFCCC. (2022). Glossary: CDM terms. Version 11.0. Available at: kutt.it/kSPC3A.

Web pages

EPA. (2023). *Landfills*. Accessed on 25th May. Available at: kutt.it/18JC4v.

Plastics Europe. (2023). *Recycling - Plastics Europe*. Accessed on 5th June. Available at: kutt.it/lhAJi5.

WRAP. (2023). *The UK Plastics Pact*. Accessed on 5th June. Available at: kutt.it/hUSLdT.

11 Document history

Version	Date	Comments or changes
1.0	29.06.2023	Initial version.
1.1	18.09.2023	Version with adjustments and changes generated after the public consultation.