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Plastic Footprint Network

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Plastic Footprint Guidelines

Module on long life items

Version 1
April 2026

Convened by EA – Earth Action • www.plasticfootprint.earth

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Introduction to the Plastic Footprint Network

Leading organizations have united within the Plastic Footprint Network to chart a new, more effective path toward plastic pollution mitigation.

The network's first priority was unifying the framework for measuring plastic leakage into a single, science-based methodology for organizations to accurately assess the environmental impact of their plastic use. Over 100 professionals from 40+ organizations collaborated to establish the methodology, consisting of 16 modules, all optimized for usability and delivery of actionable results.

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Objectives

Unifying the methodologies and perspectives of leading scientists, experts, and global practitioners, PFN enables organizations to understand the full impact, or footprint, from the use of plastic in their companies, products, and services.

1. Update and unify plastic footprinting methodologies
2. Ensure the methodology is used consistently by practitioners
3. Disseminate and scale the use of plastic footprinting
4. Explore how mitigation actions can be effectively measured and prioritized

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What will you find in this module?

The goal of this module is to provide a unified approach to estimate the contribution of plastic long life items (macroplastics) in the context of a plastic footprint. To achieve this, we will address the following questions:

1. What are the essential components of the methodology proposed in this module for estimating the contribution of long life items to a plastic footprint?

2. How does this module integrate and build upon existing approaches and literature to ensure a thorough and up-to-date assessment of the plastic footprint?

3. What secondary data sources are essential for conducting accurate estimations and how can these inputs be integrated into the overall assessment process?

At the end of this module, the users should know how to include long life items in their plastic footprint assessment.

Where does this module fit in the PFN landscape?

Guidance

Strategic | Cross-cutting or specific issue

- Introduction to plastic footprinting
- Scopes and boundaries
  Alignment with environmental reporting standards
- Data governance
- Plastic Pollution Mitigation Action Framework (PAF)

Technical

- Technical introduction to plastic leakage
- Glossary

Inventory: Macroplastics

- Packaging
- Textile
- Fishing gears
- Leakage from export
- Release rates
- Long Life Items (Current module)
- Paint
- Construction
- Automotive

Inventory: Microplastics

- Micro tire dust
- Textile Microfibers
- Micro packaging
- Micro paint
- Micro recycling
- Micro pellets

Impact

- new: Impact of Microplastic Leakage
- new: Impact Valuation

Sectoral guidance

- Agriculture
- Medical
- Apparel

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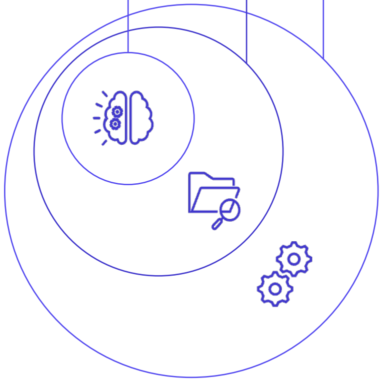
Structure of each technical module



1 Methodological choice

High level overview and different methodologies available at the moment, which one(s) to use and when.

Target audience: busy reader, scientific journalist

2 System map and calculation routes

- The different elements to take into account during a plastic footprint.
- How these elements interact.
- The calculation routes to follow.

Target audience: scientist, experts

3 Key data & background assumptions

The secondary data needed to perform the assessment and the main assumptions for the modeling.

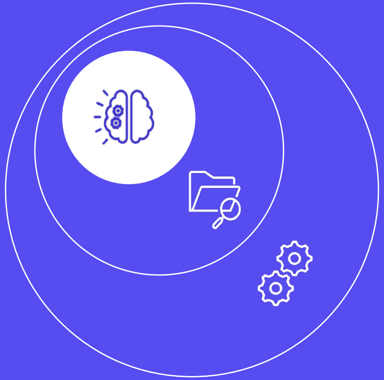
Target audience: scientist aiming at performing a plastic footprint.

Reading keys: Main take away | Supporting information | Key warning

Part. 1

Methodological choice

The different methodological approaches that can be taken, which one(s) to use and when.



Context

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The challenge of long life items footprinting

Plastic footprint assessments have so far mainly focused on single-use plastics (SUPs) and other short-life plastic products designed for brief usage before disposal. Examples include: packaging, sanitary pads, plastic cutlery, straws, food containers, etc. For these items, it is generally assumed that waste generation coincides with the year of production, or the year the item is sold to the end consumer. However, many other products are durable by design, remaining in use for years or even decades before entering waste streams. For these, different assumptions are required in footprinting.

- ***Textiles**: assumed 3–5 years, though highly variable (fast fashion <1 year, high-quality garments much longer).*
- ***Stationery & office items**: pens, folders, binders often used for several years before disposal.*
- ***Toys & sporting goods**: plastic-intensive items such as footballs, tennis rackets, ski boots, or helmets are typically kept for 5–10 years, sometimes handed down or resold second-hand before reaching end-of-life.*
- ***Small electronics & household goods**: items like headphones, kitchen tools, or plastic furniture can last from a few years to decades.*
- ***Construction & automotive plastics**: very long lifetimes, often managed through dedicated decommissioning – outside the scope of this module.*

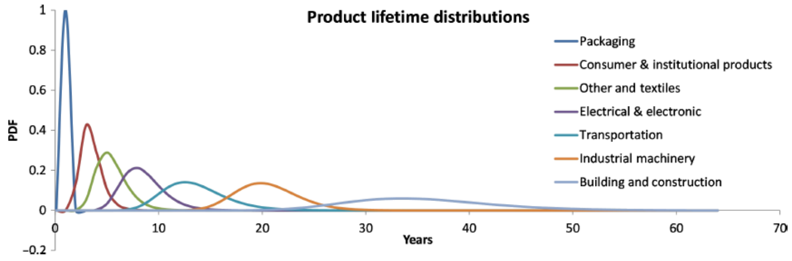


Fig 1. Product lifetime distribution for the eight industrial use sectors plotted as log-normal probability distribution functions (PDF). Note that sectors other and textile have the same PDF.
Source: Geyer et al. 2017, Production, use, and fate of all plastics ever made

Without consistent accounting rules for long life plastic items, organizations risk underestimating their delayed plastic waste impacts.

Key methodological questions for long-life plastic items

In plastic footprint assessments, leakage from long-life products may occur years or decades after production. This raises two critical methodological questions:

A

When does waste generation occur?

Three possible accounting approaches exist for products sold in year 1:

- Immediate accounting: All waste is attributed to year 1, regardless of lifetime.
- End-of-life accounting: Waste is attributed to year 1 + product lifetime, i.e. when the item is most likely discarded.
- Amortized accounting: Waste is distributed evenly over the product's expected lifetime (1/n each year).

Optionally, a probability function or uncertainty factor can be applied to reflect decreasing certainty as waste occurs further in the future.

B

How is the generated waste managed?

When projecting waste into the future, assumptions are required about the evolution of waste management systems.

- Should current (meaning at the time of analysis) infrastructure be assumed,

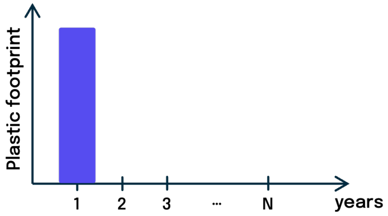
or

- Should models integrate possible improvements in collection, recycling, and disposal capacity?

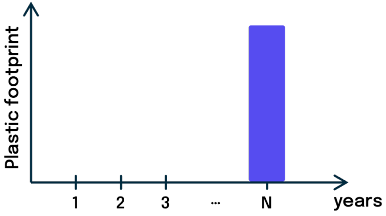
Accounting options for long-life products

In plastic footprinting, long-life products do not become waste immediately. Three methodological principles can be used to allocate their end-of-life:

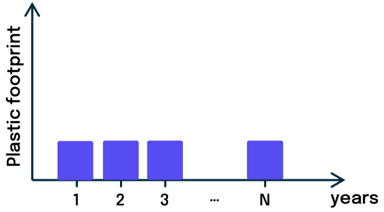
1 Immediate accounting



2 End-of-life accounting



3 Amortised accounting



Each approach has methodological implications for accuracy, comparability, and incentive structures.

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B How is the generated waste managed?

Projecting waste management for long-life products

How can we model waste management evolution over time?
When using end-of-life and amortised accounting principles, future waste management conditions can be modelled.

- Pessimistic scenario: waste management infrastructure worsens.
- Conservative scenario: current conditions persist.
- Optimistic scenario: waste management infrastructure improves.

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The choice of the scenario may depend on:

- Purpose of the assessment (e.g. disclosure, reporting, mitigation strategy)
- Geography (regional waste system performance, existing and planned policies)

Recommended approach

Default to the conservative scenario

Why:

- Waste infrastructure changes slowly because facilities are long-term investments designed to operate over many years.
- Collection and sorting systems tend to stagnate once mature.
- Significant improvements typically occur only under major regulatory or financial drivers (e.g., EPR reform, large-scale public investment).

Where it applies best:

- Countries with established EPR and relatively stable waste management.
- Short- to medium-term projections (<5 years).

When to adjust ?

Optimistic scenario if:

- National policies or corporate initiatives are already in place to expand collection, recycling, or recovery capacity.
- There is evidence of regulatory momentum (e.g., EU Circular Economy Action Plan, future NDC under a UN Plastics Treaty commitments).

Pessimistic scenario if:

- Plastic production is projected to grow without matching capacity increase.
- Regions have weak governance, insufficient funding, or high dependence on informal waste management.

Approach 1a: Immediate Accounting with Current Waste Management

All leakage is attributed to the year the product is placed on the market, using current waste management conditions

Key assumptions

- All products sold in year 1 are assumed to become waste in year 1, regardless of their actual lifetime, therefore treating long-life products (e.g., bikes, clothes, furniture) as if they were short-life items (e.g., packaging).
- No temporal gap is modelled, i.e. waste management parameters reflect today's systems.

Strengths:

- ✓ Maximum simplicity
- ✓ Historically consistent with SUP-focused footprints
- ✓ No projections required, maximizing fidelity wrt real world conditions

Limitations:

- Not representative of real waste generation long-life items
- Ignores future improvements or degradation in waste systems
- Provides no incentive to extend product lifespan

Approach 1b: Immediate Accounting with Projected Waste Management

Leakage is attributed to the year the product is placed on the market, but waste management parameters are adjusted to reflect expected conditions at end-of-life.

Key assumptions

- Responsibility is assigned at the point of sale.
- Physical leakage occurs later, but responsibility is attributed upfront.
- Waste management evolution is modelled through scenarios.

Strengths:

- ✓ Attribution consistent with carbon footprint Scope 3 accounting
- ✓ Maintains comparability across years and products
- ✓ More realistic than approach 1a for long-life items

Limitations:

- o Hybrid temporal logic (attribution ≠ occurrence)
- o Requires careful explanation to avoid misinterpretation

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Approach 2: End-of-life Accounting with Projected Waste Management

Leakage is attributed to the year when the product reaches its expected end-of-life, using projected waste management conditions.

Key assumptions

- Leakage occurs when waste is generated.
- Past sales are carried forward in time.
- Waste systems evolve until disposal.

Pros:

- ✓ Physically accurate representation of leakage timing (high temporal realism)
- ✓ Encourages longer product lifetimes and improved end-of-life management

Cons:

- Poor fit for annual corporate disclosure
- Difficult to track, update, and compare
- Weak alignment with responsibility-based accounting
- Uncertain accuracy: real discard patterns may differ from assumptions

Approach 3a: Amortized Accounting with Uniform Distribution

Leakage is distributed evenly across the expected lifetime of the product (1/n years of lifetime).

Key assumptions

- Constant probability of disposal over time.
- Waste management parameters may evolve annually.
- This method aligns with financial reporting practices for amortizable assets.

Pros:

- ✓ Smooth temporal representation
- ✓ Consistent with accounting of asset use and compatible with depreciation logic
- ✓ Useful for internal planning
- ✓ Incentivizes companies to improve both product durability and waste management

Cons:

- Artificial uniformity
- Misrepresenting real discard behaviour
- Methodologically complex, risk of double-counting
- Accuracy issues, especially under circularity scenarios
- Inherits limitations of the end-of-life approach

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Approach 3b: Amortized Accounting with Probability Distribution

Leakage is distributed across the product lifetime following a probability function (e.g. lognormal), reflecting observed discard patterns.

Key assumptions

- Disposal likelihood increases around typical end-of-life.
- Uncertainty is explicitly modelled.

Pros:

- ✓ Most realistic dynamic representation
- ✓ Strong scientific grounding
- ✓ Well suited for mitigation strategy modelling

Cons:

- Data- and computation-intensive
- Not suitable for headline disclosure metrics

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Time distribution of leakage overtime

This table summarizes how each accounting approach translates into the temporal allocation of plastic leakage and the way product lifetime is incorporated into the calculation.

Approach	When is waste generated?	How lifetime is used	Leakage allocation
1a / 1b	Year of sale (Y)	Not used	100% in year Y
2	End-of-life (Y + L)	Average lifetime	100% at end-of-life
3a	Across lifetime	Average lifetime	Uniform (1/L per year)
3b	Across lifetime	Distribution (PDF)	Weighted by probability

The only difference between approaches is the time allocation function applied to the same base equation, in other words approaches differ only in how this leakage is distributed over time.

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Recommended approach: Attribution vs. physical occurrence of leakage

In plastic footprinting, a distinction exists between the physical occurrence of plastic leakage and its responsibility attribution.

While both logics are valid, they are best used for different purposes.

Physical occurence:

- When waste is actually generated
- When leakage physically happens, i.e. when plastic reaches environmental compartments
- Reflects real-world timing

Used in:

- **Approach 2**
- **Approach 3a / 3b**

Attribution:

- When responsibility is assigned
- Linked to year of sale
- Enables consistent reporting

Used in:
Approach 1a / 1b

Attributional approaches (1b) are recommended for corporate disclosure, ensuring comparability and alignment with reporting practices.
Physically representative approaches (3b / 3a) are recommended for mitigation strategy modelling, where the timing of leakage is critical.

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When to use which? Disclosure vs. Mitigation Strategy

Choosing the appropriate approach to account for the leakage of long-life items is dependent on the use made of the assessment.

Disclosure → approach 1b: Immediate Accounting with Projected Waste Management

- Aligned with Scope 3 sold products logic in carbon accounting
- Responsibility-based
- Allows forward-looking assumptions without shifting reporting years
- Avoids artificial drops/spikes in reported footprints

✓ **PFN recommended approach for corporate disclosure of long-life items.**

Mitigation strategy → approach 3b: Amortized Accounting with Probability Distribution

- Mitigation is about when and how leakage reductions materialise
- Design, durability, reuse, and take-back schemes all act over time
- 3b allows:
  1. Scenario comparison
  2. Sensitivity analysis
  3. Alignment with infrastructure planning

✓ **PFN's preferred for leakage mitigation strategy design.**

Fallback approach 3a: Amortized Accounting with Uniform Distribution

✓ **PFN suggests approach 3a as the fallback method when data is limited.**

When to use which?

Purpose of assessment	Recommended approach	Rationale
Corporate disclosure / reporting	1b	Ensures impacts are attributed to the year of sale, enabling consistent and comparable annual reporting.
Baseline footprint	1b	Maintains stable year-on-year comparability across metrics and avoids shifts in leakage across reporting periods.
Mitigation strategy design	3b (preferred) / 3a (fallback)	Captures when leakage occurs over time, allowing assessment of how interventions (e.g. durability, reuse) affect outcomes.
Internal planning (simplified)	3a	Provides a simple time-distributed estimate of leakage without requiring detailed modelling assumptions.
Academic or policy analysis	2	Enables analysis of when leakage physically occurs, supporting system-level modelling, policy design, and anticipation of future leakage peaks and infrastructure needs.
Legacy SUP-focused footprints	1a	Suitable for short-lived products where waste generation occurs almost immediately after use, making immediate attribution a reasonable approximation.

Approach 2, while methodologically valid, is not recommended for standard corporate plastic footprinting, but may be relevant for:

- Academic research
- Policy analysis
- System-level modelling
- Retrospective studies of future leakage peaks

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Recommended methodological approach

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Steps:

1. Collect primary data: the mass of plastic items and in which countries they're used.
2. Choose accounting approach: select one among the five accounting approaches – immediate with current or projected waste management, end-of-life with projected waste management, or amortised with uniform or probability distribution – and determine the value of the accounting factor, λ_A, accordingly.
   For the amortised approach, it is necessary to collect data about the item's lifetime.
3. Choose the waste management scenario: except for the immediate accounting, the other approaches require information about the future state of the waste management infrastructure, particularly, the evolution of the MWI. Select one of the modelling scenarios – conservative (recommended), optimistic, or pessimistic – and determine the value of the scenario factor, λ_B, accordingly.
4. Compute the compound rate: by means of the scenario factor, compute the waste management infrastructure compound growth rate by elevating $1 + \lambda_A$ to the power of Y-1.
5. Compute mismanaged waste on year Y: Apply the country-specific MWI, as well as the accounting factor and compound rate, to the mass of plastic items. Sum over all countries.
6. Compute leakage on year Y: Apply the release rates to the mass of mismanaged waste.

⚠ The formula computes annual plastic leakage from long-life items for year Y (reference year). In the immediate accounting approach, all leakage occurs in year 1. In the end-of-life accounting approach, all leakage occurs in year $Lifetime$. In the amortised accounting approach, the formula gives the annual leakage from year 1 to year $Lifetime$.

$$\text{Leakage}^{Y}_{comp}(t) = \sum_{country} M_{country}(t) * \lambda_A * \text{MWI}_{country}(\%) * (1 + \lambda_B)^{Y-1} * RR_{comp}(\%)$$

where compartment (*comp*) = water, land

Primary data needed:

- Total weight (tonnes) of plastic long-life items sold or used
- Item's average lifetime (if needed)

Secondary data needed:

- Mismanaged Waste Index (MWI)
- Release rates (RR)

Accounting factor λ_A	Immediate accounting	$\begin{cases} 1, & Y=1 \\ 0, & \text{otherwise} \end{cases}$
	End-of-life accounting	$\begin{cases} 1, & Y=Lifetime \\ 0, & \text{otherwise} \end{cases}$
	Amortised accounting (uniform)	$1/Lifetime$
	Amortised accounting (probability)	Refer to next slide.

Scenario factor λ_B	Conservative scenario	0%
	Optimistic scenario	Sec. data
	Pessimistic scenario	Sec. data

⚠ Release rates should be adapted to the geography and should vary according to the type of waste mismanagement (uncollected, dumpsite, etc). If this is not possible, use 10% as a global value.

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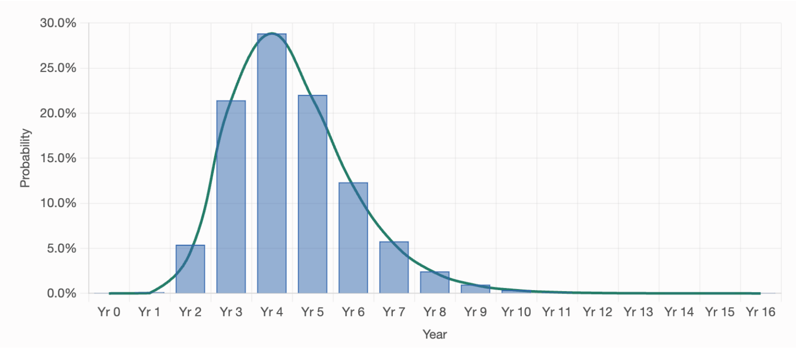
Amortized accounting with lognormal distribution: accounting factor

As recommended by Geyer and collaborators, we assume a lognormal distribution for the lifetime of a generic product. To determine the accounting factor λ_A at a year Y, it is necessary to integrate the distribution function between Y and Y+1.
For a lognormal distribution, this integration yields:

$$\lambda_A = Probability\ year\ Y = \Phi(z_{Y+1}) - \Phi(z_Y)$$

where Φ is the standard normal cumulative distribution function and

$$z_Y = \frac{\ln(Y) - \ln\left(\mu^2/\sqrt{\mu^2+\sigma^2}\right)}{\sqrt{\ln(1+\sigma^2/\mu^2)}}$$



with μ and σ being, respectively, the mean (or avg lifetime) and standard deviation of the product considered.

Step-by-step procedure

- Determine μ and σ based (when available) on product-specific secondary data, or on the sector-generic values reported in this module.
- Calculate z_Y and z_{Y+1}.
- Use available numeric tables to determine the values of $\Phi(z_{Y+1})$ and $\Phi(z_Y)$, and therefore of λ_A. This can be done, for instance, via the Excel function `NORM.S.DIST`: $\Phi(z)$ = `NORM.S.DIST(z, TRUE)`.

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Part. 2

System map & calculation routes

The different elements to take into account during a plastic footprint. How these elements interact? Which calculation routes to follow?

Calculation routes for leakage at end-of-life

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$$MW^{Y}(t) = \sum_{country} M_{country}(t) * \lambda_A * MWI_{country}(\%) * (1 + \lambda_B)^{Y-1}$$

$$Leakage^{Y}_{comp}(t) = \sum_{country} M_{country}(t) * \lambda_A * MWI_{country}(\%) * (1 + \lambda_B)^{Y-1} * RR_{comp}(\%)$$

where compartment (*comp*) = water, land

END OF LIFE

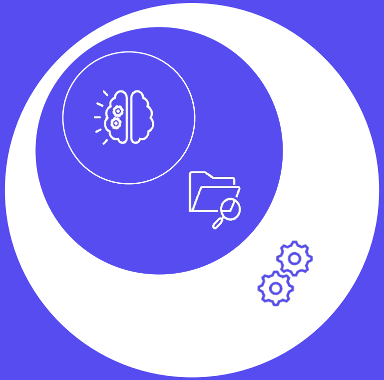
The formula computes annual plastic leakage from long-life items for year Y (from the reference year). In the immediate accounting approach, all leakage occurs in year 1. In the end-of-life accounting approach, all leakage occurs in year $Lifetime$. In the amortised accounting approach, the formula gives the annual leakage from year 1 to year $Lifetime$.

Symbol	Description	Unit	Value	Reference	Additional comments
$M_{country}$	Mass of plastic items produced/sold	Tonnes	From primary data		
Y	Year number from the reference year		From primary data		The reference year being the year when the product is put on the market.
$MWI_{country,}$	Mismanaged Waste Index	%	Secondary data	Country-specific data available for certain countries and for packaging in PLASTEAX. For other countries, data based on World Bank What a Waste database, improved version by EA.	In the absence of secondary data specific to the plastic item considered, PLASTEAX generic data can be used, knowing that these apply to packaging and might significantly differ from the real data.
λ_A	Accounting factor: depends by the chosen accounting approach		Secondary data/ From this module	Values for the average lifetime of products in selected sectors are reported in the Data section of this module.	Immediate accounting: 1 for year 1, 0 otherwise. End-of-life accounting: 1 for year $Lifetime$, 0 otherwise. Amortised accounting: $1/Lifetime$
λ_B	Scenario factor: depends by the chosen waste management scenario	%	Secondary data/ From this module		For optimistic (pessimistic) scenarios, λ_B should be positive (negative).
$RR_{compartment}$	Release rates to water and land	%	From upcoming Release rates module		
MW	Quantity lost in the environment	Tonnes	Calculated		
$Leakage_{compartment}$	Quantity released to ocean and waterways	Tonnes	Calculated		

Part. 3

Data

The secondary data needed to perform the assessment.



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Products' lifetime

Sector	Avg lifetime (years)	Standard deviation
Packaging	0.5	0.1
Transportation	13	3
Building and Construction	35	7
Electrical and Electronics	8	2
Consumer and Institutional Products	3	1
Industrial Machinery	20	3
Other	5	1.5
Textile	5	1.5

From: R. Geyer, J. R. Jambeck, K. L. Law, Production, use, and fate of all plastics ever made. Sci. Adv. 3, e1700782 (2017).

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Avenues for future methodological developments

Area	Key developments	Additional detail
Scope extension	Develop methodology for microplastic emissions	Include wear, fragmentation, and secondary microplastics from long-life items
Scenario modelling	Refine optimistic and pessimistic pathways	Integrate policy targets, infrastructure investment, and production growth assumptions
Time horizon	Define appropriate modelling horizons	Align with product lifetime, reporting cycles, and scenario consistency (e.g. 5–20 years)
Temporal modelling	Improve lifetime distributions	Better represent discard behaviour, variability, and reuse effects
Data consistency	Strengthen alignment of MWI and scenarios	Ensure consistency with available datasets and improve comparability across users

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Our mission is to continuously advance Plastic Footprint Methodology, ensuring it remains at the forefront of sustainable practices and promoting its widespread adoption. By empowering companies to rigorously assess, enhance, and transparently report their plastic footprints, we aim to make significant strides in mitigating the plastic pollution crisis.

Plastic Footprint Network

This working group was established to develop a scientifically robust and practical methodology for estimating the contribution of plastic long life items in the context of a plastic footprint. It follows PFN's structured process, ensuring scientific integrity, peer review, and alignment with global standards.

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Working group lead

(Responsible for developing the methodology, ensuring scientific rigor, and managing the working group)

earth action

Contributing companies

(Experts, stakeholders, and industry representatives, who provided insights, data, or case studies to inform the methodology)

evea

earth action

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ea for impact

The Plastic Footprint Network
is convened by EA for Impact,
the non-profit arm of Earth Action.

Illustrations by German Kopytkov

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