Normalisation, weighting, and integration

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1. Current approach of EF methods

In EF3.1, the Environmental Footprint (EF) methods address two optional steps of the ISO's guidance for the Life Cycle Impact Assessment (LCIA) phase of LCA studies: normalisation and weighting. These processes are used to aggregate different impact results into a single score. This can be used to support interpretation and communication of results, and taking more informed decisions. More specifically:

1.1. Normalization

Purpose: Normalization transforms characterised results from the individual impact categories (presenting different metrics) into a unitless numerical value that enables comparisons among categories. This is obtained by relating a characterized value to reference system (presenting the same metric). In practice, this means dividing impact results by normalisation factors.

Normalisation factors: EF3.1 includes 16 normalization factors, each corresponding to a specific LCIA midpoint indicator. Each factor is obtained by characterising the global inventory flows with the associated characterisation factors.

Normalization Inventory: EF3.1 adopts a global normalization inventory, which is described in Sala et al. 2017[1]. This inventory uses as much as possible available statistics on environmental emissions and resource use, complemented by modelled data. The current normalisation set uses an inventory set in 2010 and largely based on EU statistics. When data is collected at the EU level, data is extrapolated globally based on GDP, following the methodology outlined in Cucurachi et al. 2014[2]

1.2. Weighting

Purpose: Weighting assigns relative importance to each of the impact categories, aggregating impact results after normalisation into a single score that represents the overall environmental footprint. This process helps to simplify complex environmental data into a comprehensible and communicable format.

Weighting factors: the weighting factors in EF3.1 are designed to reflect the relevance and robustness of each impact category. The current weighting scheme was developed in 2018 after an extensive consultation exercise[3] and is considered a reference due to the broad consensus reached. The weighting factors consider both the environmental significance of each impact category (i.e. relevance) and the robustness used to assess them.

Robustness Factors: These factors account for the uncertainty and variability in the data and methods used to assess each impact category, ensuring that the weighting scheme is reliable and

[1] Pant, R., Sala, S., Crenna, E. and Secchi, M., Global normalisation factors for the environmental footprint and Life Cycle Assessment, Publications Office, 2017, https://data.europa.eu/doi/10.2760/88930

[2] Cucurachi, S.; Sala, S.; Laurent, A.; Heijungs, R. Building and Characterizing Regional and Global Emission Inventories of Toxic Pollutants. Environ. Sci. Technol. 2014, 48 (10), 5674–5682. https://doi.org/10.1021/es405798x.

[3] Cerutti, A. K., Pant, R. and Sala, S., Development of a weighting approach for the environmental footprint, Publications Office, 2018, https://data.europa.eu/doi/10.2760/945290

consistent with expected results. The robustness was evaluated with a I-to-III score (with I means better and III worse) assigned to

1) inventory completeness;

2) inventory robustness; and

3) LCIA method level of recommendation.

For instance, the GWP100 results in II, II and I, respectively; while toxicity is III, III and III. The resulting robustness factors are 0.87 for GWP and 0.17 for toxicity. Multiplied by the respective environmental relevance factors, the following overall weighting factors are obtained: 21% for GWP and about 2% for toxicity.

1.3. Integration

The current version of the EF methods also allows for the quantification of additional information, which cannot be aggregated in the single score and must be reported separately.

2. Issues and main developments

During the work for the update of EF methods, it appeared necessary to review the normalisation, weighting and integration approach, among other reasons to take into account recent EF developments on impact categories, the temporal accuracy of normalisation and the appropriateness of the weighting scheme. This was introduced and discussed with the TAB on 25June 2025, receiving 16 comments covering the topic. Normalisation

Four options were presented for updating normalisation in EF4:

A. Maintaining an external global normalisation reference approach, updating the inventories, whenever possible, using the same sources used for the inventory in EF3.

B. Keeping an external global normalisation factor, but adopting the global inventory from GLAM as released, which would require performing an assessment and testing of the data sources case by case.

C. Shifting to a normalisation reference derived from the EF4 database, which requires to build a comprehensive model representing global supply chains instead of collecting global inventory data from statistical bodies.

D. Shifting to "internal" normalisation references based on benchmarks defined in PEFCRs.

Feedback received:

- To update the inventory is crucial. Stakeholders emphasized that updating the inventory is essential for maintaining the robustness and relevance of normalisation factors. Most respondents preferred updating the current sources (7 preferences for Option A) or aiming at GLAM alignment (6 preferences for Option B). To note that the update of the current EF sources (option A) is mostly aligned to GLAM (option B), since most of the sources are the same.

- Only one stakeholder suggested that the normalisation factors should be derived from the EF4 database in the long run to ensure consistency (Option C), which would mean relying on data provider ability to collect meaningful data.

- Another stakeholder advocated the possibility of developing specific normalisation factors as part of the PEFCRs, when meaningful for the sector/product category and reasonable data sources are available (Option D). However, this might also be perceived as additional burden for PEFCRs (1 feedback).
- The use of planetary boundaries for normalisation was also proposed as a fifth option[4]. Planetary boundaries are increasingly recognized in international policy discussions and agreements, such as the United Nations Sustainable Development Goals (SDGs) and the European Union's Circular Economy Action Plan. However, despite this is a reasonable route, it is acknowledged that this could be considered only for future discussions.

2.1. Weighting

Five non-mutually excluding options were considered for the weighting approach:

A. Keeping the weighting factors scheme as in EF3, adapting the individual weights to fit new indicators (i.e. land use – biodiversity and microplastics).

B. Adjusting the weighting factors by referring to AOPs (Area of Protection), where each impact category reflects a share of the AOP weighting factor. Namely these are human health; ecosystem quality; resource availability (see figure 1).

C. Adjusting current weighting factors by removing the robustness factor from the weighting.

D. Adapting weighting factors depending on specificities of sectors or policies (e.g. changing the weights or excluding some indicators).

E. Fully reshaping the weighting set framework to include additional environmental information launching a new weighting exercise in the long term.

Impact Categories	Weighting factors (%- WF(%)	Effect on HH	Effect on EQ	Effect on NR	WF_HH	WF_EQ	WF_NR
Climate change	19.5	0.59	0.29	0.12	11.55	5.63	2.34
Ozone depletion	5.7	1.00			5.74		
Human toxicity, cancer effects	2.3	1.00			2.34		
Human toxicity, non-cancer effects	2.0	1.00			2.02		
Particulate matter/Respiratory inorganics	9.5	1.00			9.47		
Ionizing radiation, human health	3.3	1.00			3.25		
Photochemical ozone formation, human health	3.8	0.80	0.20		3.06	0.76	
Acidification	5.1		1.00			5.08	
eutrophication, terrestrial	3.1		1.00			3.09	
eutrophication, freshwater	2.6		1.00			2.60	
eutrophication marine	3.1		1.00			3.08	
Ecotoxicity freshwater	2.1		1.00			2.09	
land use – soil	7.1			1.00			7.14
Resource use, water	10.1	0.44	0.30	0.26	4.41	3.05	2.62
Resource use, fossils	6.9			1.00			6.87
Resource use, mineral and metals	7.6			1.00			7.58
land use biodiversity	6.2		1.00			6.24	
sum					41.8	31.6	26.5

Figure 1 Proposal for weighting subdivided in Areas of protections (AoPs)

Feedback received:

[4] A Planetary Boundaries-based normalisation set was published for the Environmental Footprint 3.1 and available in Annex 1 in Sanyé Mengual et al., 2025. Reference: https://publications.jrc.ec.europa.eu/repository/handle/JRC138470

- Four experts explicitly supported reshaping the weighting set to include the new impact categories, possibly reflecting planetary boundaries.
- Six experts were not in favour of subdividing the weighting in the AOPs, as they found it less clear for interpreting the results. However, some are open to this approach if more guidance is provided.
- Three experts expressed openness to the possibility of tailoring weighting factors for different sectors of specific goals. However, this would be more of a political decision. In general, experts were not supporting this option, and two experts proposed that the weighting factors should be based on the number of ecosystems or people affected and the severity of the impacts.
- While two stakeholders supported the removal of robustness factors, eight stakeholders were against such removal as it is considered to provide valuable information about the interpretation of the impact categories.

2.2. Integration

Ad hoc indicators, and the possibility of integrating additional information into a single score through a bonus/malus or scoring system, could also be considered on a case-by-case.

Feedback:

- Experts generally consider that a bonus/malus system is not aligned with LCA principles and could bias the results, in fact none of the respondent was clearly in favour. A few experts expressed openness to the aggregation of a closed list of additional information (2 expers) into a single score under case-specific conditions (3 experts).
- The Eco Food Choice consortium discussed the possibility of using a bonus/malus system linked to organic certification, but the ultimate choice was to exclude it for the moment due to the subjective quantification and weighting of biodiversity benefits.
- There seems to be consensus that technical-scientific efforts should rather focus on improving inventories and LCIA methods.

3. Proposed way-forward

This section introduces a proposal for the current update of the EF methods recommendation.

3.1. Normalisation:

To ensure the robustness and relevance of the EF methods, it is proposed updating the life cycle inventory keeping the same data sources as in EF3. This approach provides a consistent basis for comparison and maintains the methodological coherence established in previous versions. Normalisation factors will be then calculated by multiplying the updated inventory with the characterisation factors of the updated EF 4.0 LCIA method.

The inventory completion is planned by Q4 2025, with testing planned in 2026. Longer-term developments should aim to achieve alignment with the GLAM and/or consider alignment with planet boundaries.

Challenges:

- It is currently impossible to update the toxicity and ionising radiation indicators using GLAM normalisation since the inventory of GLAM refers to ecoinvent data and would raise an inconsistency issue. For example, it is not fully aligned with the external global normalisation reference used for the other EF categories, i.e. based on real emissions inventories.
- For toxicity, an update exercise is planned at the JRC, aiming to update the inventory using the same approach adopted in EF3.1. Detailed updates and methodologies will be shared with stakeholders to ensure transparency and collaboration.
- For ionising Radiation, it is likely that no update will be performed for this indicator in the near term.

3.2. Weighting

Weighting factors will be recalibrated to consider two additional impact categories:

- Land use – biodiversity: it was possible to derive a weight since the impact was included in the original survey
- Microplastics: the proposal is to share part of the weight with the toxicity indicators (further discussion needed).

Furthermore, to enhance the flexibility, relevance and interpretation of EF studies, a two-step approach is proposed that consider aggregation into three areas of protection, (human health; ecosystem quality; resource availability) and then single score.

The separation of various AOPs can help to create differentiated weighting sets to support interpretation and communication of EF results, while maintaining the robustness of EF methods.

Considering some uncertainties or controversies for certain applications, it may also be considered necessary to limit weighting (not the characterisation steps) only to the most relevant and/or robust impact categories for that application. Such adaptation will have to be duly justified in the application of EF methods (e.g. in PEFCRs). However, further reflections may be needed.

An exercise for the most systematic review of weighting factors could be launched in the future, but this will require time and could only be considered as longer-term development beyond the timeline for the current update of EF methods.

3.3. Integration

It is proposed that the focus of EF methods should remain on the aggregation of "official" LCIA impact categories into the single score. This is a more rigorous approach, compared to bonus/malus or scoring systems, which would not risk compromising the integrity of LCA/EF methods. Recent work by the Commission has been oriented towards the aggregation of new LCIA categories (microplastics and biodiversity).

Recent developments have also addressed the consideration of complementary indicators and additional information to be shown separately (e.g. for fish-stock depletion, substances of concern, extraction of non-metallic resources).

At this stage, it is premature to propose a robust bonus/malus or scoring system within the EF framework. However, the elements of EF methods could be potentially used to derive such type of systems, where needed.

Depending on the application, and to support the interpretation phase, EF studies may also consider other approaches to integrate different information, e.g. internal normalisation and MCDA for the comparison of different design options (see ORIENTING project).

References

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List of abbreviations and definitions

Abbreviations	Definitions
EF	Environmental Footprint
LCIA	Life Cycle Impact Assessment
GLAM	Global Guidance for Life Cycle Impact Assessment Indicators and Methods
PEFCR	Product Environmental Footprint Category Rule
AOP	Area of Protection