Section: "Changes in normalisation and weighting factors (PEF, planetary boundaries, etc.)"

SCORE LCA

Thursday, 19 March 2026

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Project context and objective

Possibility of **normalisation and weighting life cycle assessment (LCA) impact results,** based on the general requirements and recommendations in ISO 14074 and PEF factors *

Project objective

Propose methodological and quantified **improvements** to normalisation and weighting factors that **are compatible with planetary boundaries.**

The results of this SCORE LCA work may contribute to the future content of the PEF and normative work.

References

- European Commission. *PEFCR guidance, v.6.3.2*
- Principles, requirements and guidelines for normalisation, weighting and interpretation – *ISO/TS 14074:2022*
- Environmental sustainability of European production and consumption assessed against planetary boundaries – *Sala et al - 2020*

Issues

Normalisation and weighting for calculating a single score > simplifies results and decision-making:

- Normalisation based on the average annual impact of a citizen worldwide (questionable reference)
- Panel approach (experts, citizens) for defining weighting factors
- Lack of consideration of the concept of real or absolute sustainability

SCORE LCA study process

Start: October 2024
End: October 2025

1. Establish a state-of-the-art bibliography
2. Illustrate the issues with case studies
3. Make methodological recommendations

* **European Commission** (2018). *Product Environmental Footprint Category Rules (PEFCR) guidance*, version 6.3.2, May 2018.

State of the art: normalisation and weighting (general principle)

Normalisation and weighting:

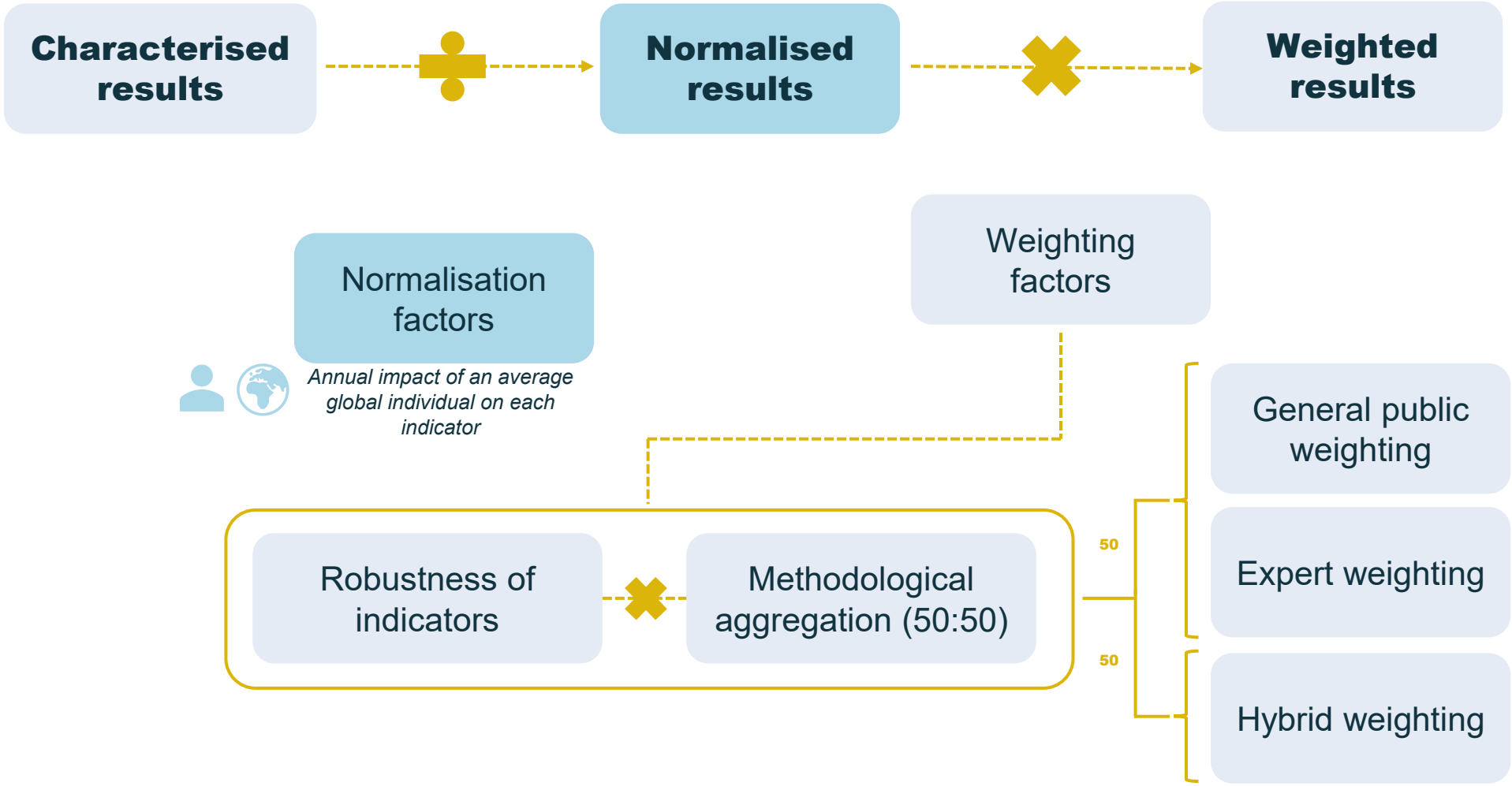
- are **optional** steps
- contribute to a better **interpretation** of the results,
- facilitate **decision-making**
  - → by making LCA results **accessible** and **operational**
  - → by **prioritising** issues
- are defined and regulated in the **ISO/TS 14074:2022** standard

Principle of arbitration: normalisation and weighting lead to **trade-offs** in the importance of impact categories (notion of value choice)

These trade-offs are **not always visible** and **explicit** and vary according to spatial and temporal scales and cultural priorities

- Document the **raw results**, **normalisation and weighting factors** used
- Choose the reference system and weighting data based on their **regional and temporal relevance**

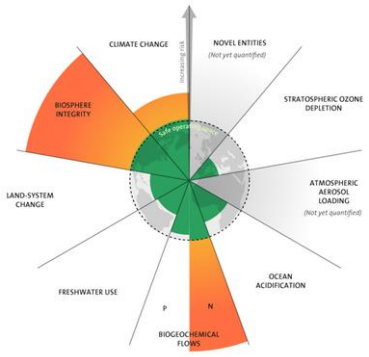
State of the art: normalisation and weighting – the case of the PEF



State of the art: Planetary boundaries – presentation of the concept

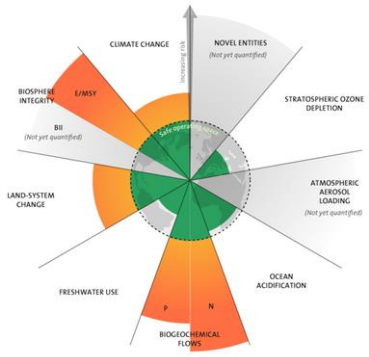
- **Proposed in 2009** by an international team of researchers from ***the Stockholm Resilience Centre***
- Identifies boundaries that must not be exceeded in order to ensure that the Earth's ecosystem remains in the Holocene, its current state for approximately 10,000 years. These boundaries define a safe space for the human species: the **Planetary Boundary** or *Safe Operating Space*
- **Last updated in September 2025**: 7 out of 9 boundaries exceeded
- Climate change and biodiversity loss are the two most critical boundaries, as they alone can tip the Earth system into collapse. All boundaries (issues) are more or less interrelated.

2009



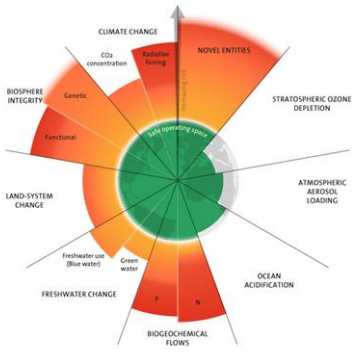
7 boundaries assessed,
3 crossed

2015



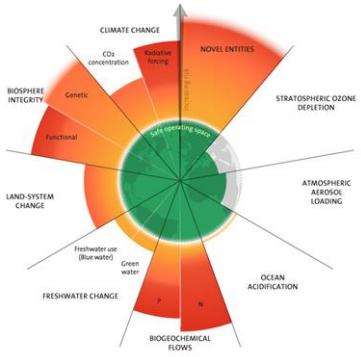
7 boundaries assessed,
4 crossed

2023



9 boundaries assessed,
6 crossed

2025



9 boundaries assessed,
7 crossed

Source: Azote for the Stockholm Resilience Centre (Stockholm University), based on Sakschewski and Caesar *et al.*, 2025; Richardson *et al.*, 2023; Steffen *et al.*, 2015; Rockström *et al.*, 2009.

State of the art: LCA and planetary boundaries coupling

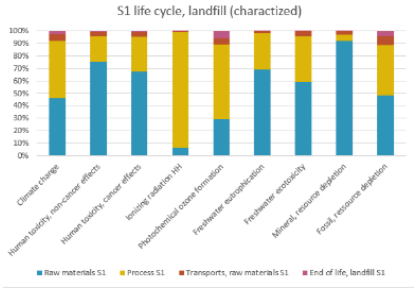
3 possible approaches

3 options

1

CHARACTERISATION

Use of indicator characterisation factors (from modelled flows to impacts)



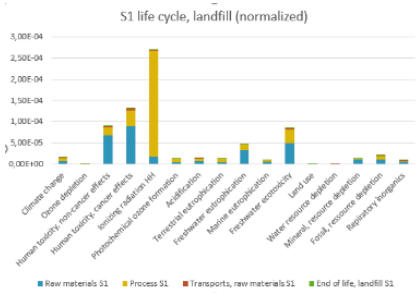
Characterised results
E.g.: Climate change
111 g CO_2

OR new specific indicators (AESA) *

2

NORMALISATION

Average annual impact per person (worldwide)
E.g.: climate change = 7,550 kg CO_2



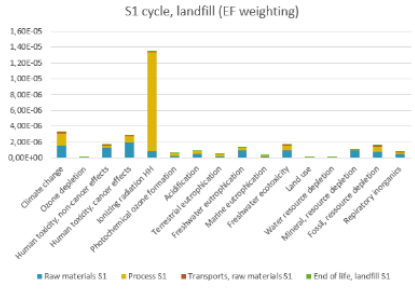
Normalised results
Division by the normalisation factor
0.111/7550 = 1.47 E-5 Pt = 14.7 µPt

OR normalisation (AESA) *

3

WEIGHTING

Multiplication by the weighting factor
E.g.: Climate change 21.06%.



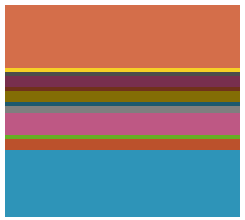
Weighted results
E.g.: Climate change
14.7 µPt * 21.06% = 3.09 µPt

OR weighting

4

SINGLE SCORE

Sum of the weighted scores of the 16 indicators



Unit = Pt
1 Pt = Average annual impact average annual of one person (World)

Methods implemented in this project

* **AESA:** *Absolute Environmental Sustainability* Assessment

Case study: activity data and methods used

Case study presented for this presentation

- **Case study no. 1** 🔧: comparison of methods for generic material data, **1 kg of global steel**
- **Case study no. 2** ⚡: comparison of methods for generic energy data, **1 kWh of French electricity**
- **Case study no. 3** 🚗**:** comparison of methods for generic mobility data, **1 km travelled by private car in Europe**

For each case study and generic data, we compared:

1. The current PEF method (EF 3.1)
2. The consideration of planetary boundaries with weighting (after conventional PEF normalisation)
3. Absolute LCA or AESA, using planetary boundary normalisation factors and product or service downscaling/upscaling

Results steel 1 PLP

Comparison 1 Current PEF VS 2 planetary boundary limits (PBL) weighting

- The characterised results are obviously identical (e.g. 2.12 kgCO2e/kg)
- Identical normalisation between the two approaches (traditional PEF, World)
- The selection of indicators is slightly different, but in the same order
- A slightly different single gross result score (+2.7%)

Data used in ecoinvent:
1kg of "Steel, low-alloyed {GLO}| market for steel, low-alloyed | Cut-off, S"

1 CURRENT PEF

Contribution to single score > 80%:

Climate change	**32.4**
Fine particulate matter	**15.8**
Use of minerals and metals	**15.2**
Use of fossil resources	**9.3**
Acidification	**5.4**
Human toxicity, carcinogenicity	**4.9**

Single score = 182.3 µPts

2 PLP

Contribution to single score > 80%:

Climate change	**38.2**
Fine particulate matter	**27.9**
Use of minerals and metals	**9.9**
Use of fossil resources	**6.7**

Single score = 187.2 µPts (+2.7%)

Method steel 3 AESA

EQUALITARIANISM
Distribute the budget equally among every individual on Earth
> absolute threshold not to be exceeded per person/year
> shift from global scale to individual scale

1 **Characterised impact**

2 **Estimation of acceptable load capacity for the product/sector**

= share of the pie (%)

3 **Environmental budget allocated to the product/sector per individual per year**

= LP threshold/individual/year

4 **Sustainable environmental budget in AESA for the product/service per individual per year**

= / (average total consumption/individual/year)

UTILITARIANISM
Share of the product/sector in the economy

OR

ACQUIRED RIGHTS/GRAND FATHER RIGHTS
Share of the sector/product in overall impacts

= 1 Impact caractérisé / =

5 **Ratio between current product impact VS sustainable product**

Results steel 3 AESA

UTILITARIANISM ADDED VALUE

Indicateurs ACV	Unité	1 Impacts caractérisés	2 allocation par secteur	3 budget enviro acier/personne/an	4 Budget enviro 1 kg acier soutenable	5 Ratio et distance à la cible
Climat change	kg CO2 eq	2,12E+00		5,71E+00	2,43E-02	87,27
Ozone depletion potential	kg CFC-11 eq	1,02E-08		4,52E-04	1,92E-06	0,01
Human toxicity, cancer	CTUh	7,24E-09		8,06E-07	3,43E-09	2,11
Human toxicity, non-cancer	CTUh	3,99E-08		3,44E-06	1,46E-08	2,73
Particulate matter	Disease incidence	1,91E-07		4,33E-07	1,84E-09	103,90
Ionising radiation	kBq U-235 eq.	2,36E-02		4,42E+02	1,88E+00	0,01
Photochemical ozone formation	kg NMVOC eq.	6,90E-03		3,41E-01	1,45E-03	4,76
Acidification	mol H+ eq	8,89E-03		8,41E-01	3,57E-03	2,49
Terrestrial eutrophication	mol N eq	2,06E-02		5,14E+00	2,19E-02	0,94
Freshwater eutrophication	kg P eq	1,19E-04		4,87E-03	2,07E-05	5,74
Marine eutrophication	kg N eq	1,88E-03		1,68E-01	7,15E-04	2,63
Land use	Pt	7,02E+00		4,37E+03	1,86E+01	0,38
Ecotoxicity freshwater	CTUe	1,11E+01		1,10E+02	4,68E-01	23,68
Water depletion	m3 water eq	4,48E-01		1,53E+02	6,48E-01	0,69
Resource depletion – fossils	MJ	2,16E+01		1,88E+02	7,99E-01	27,05
Resource depletion - minerals	kg Sb eq	1,43E-05		1,84E-04	7,84E-07	18,18

Utilitarisme (Valeur ajoutée et PIB)

$$\frac{VA\ Sidérurgie\ Monde}{PIB\ Mondial} = \frac{500\ Mds}{86\ 880\ Mds} = 0{,}58\%$$

- Product not sustainable for 11 out of 16 indicators
- Reducing impacts is not realistic (divide by 87 for climate change, etc.)
- Added value seems not relevant to intermediate goods (even if essential)
- Difficult or impossible to use household expenditure share (in steel per year)

ACQUIRED RIGHTS

Indicateurs ACV	Unité	1 Impacts caractérisés	2 allocation par secteur	3 budget enviro acier/personne/an	4 Budget enviro 1 kg acier soutenable	5 Ratio et distance à la cible
Climat change	kg CO2 eq	2,12E+00	6,889%	6,79E+01	2,88E-01	7,35
Ozone depletion potential	kg CFC-11 eq.	1,02E-08	0,012%	9,26E-06	3,94E-08	0,26
Human toxicity, cancer	CTUh	7,24E-09	5,120%	7,12E-06	3,03E-08	0,24
Human toxicity, non-cancer	CTUh	3,99E-08	2,295%	1,36E-05	5,78E-08	0,69
Particulate matter	Disease incidence	1,91E-07	7,275%	5,43E-06	2,31E-08	8,28
Ionising radiation	kBq U-235 eq.	2,36E-02	0,153%	1,16E+02	4,94E-01	0,05
Photochemical ozone formation	kg NMVOC eq.	6,90E-03	4,641%	2,73E+00	1,16E-02	0,60
Acidification	mol H+ eq	8,89E-03	4,366%	6,33E+00	2,69E-02	0,33
Terrestrial eutrophication	mol N eq	2,06E-02	3,181%	2,82E+01	1,20E-01	0,17
Freshwater eutrophication	kg P eq	1,19E-04	4,421%	3,71E-02	1,58E-04	0,75
Marine eutrophication	kg N eq	1,88E-03	1,813%	5,26E-01	2,23E-03	0,84
Land use	Pt	7,02E+00	0,137%	1,03E+03	4,39E+00	1,60
Ecotoxicity freshwater	CTUe	1,11E+01	25,615%	4,87E+03	2,07E+01	0,54
Water depletion	m3 water eq	4,48E-01	1,065%	2,80E+02	1,19E+00	0,38
Resource depletion – fossils	MJ	2,16E+01	9,037%	2,93E+03	1,24E+01	1,74
Resource depletion - minerals	kg Sb eq	1,43E-05	6,111%	1,94E-03	8,26E-06	1,73

- Product not sustainable for 5 out of 16 indicators
- To be divided by 7 for *climate change* or 8 for fine particles, which is much more realistic → division by 5 in the **Steel Sector Transition Plan** by 2050 for GHGs in France
- This would therefore not be sufficient; it implies taking action on the levers of sobriety/volume of steel production.

Key methodological lessons

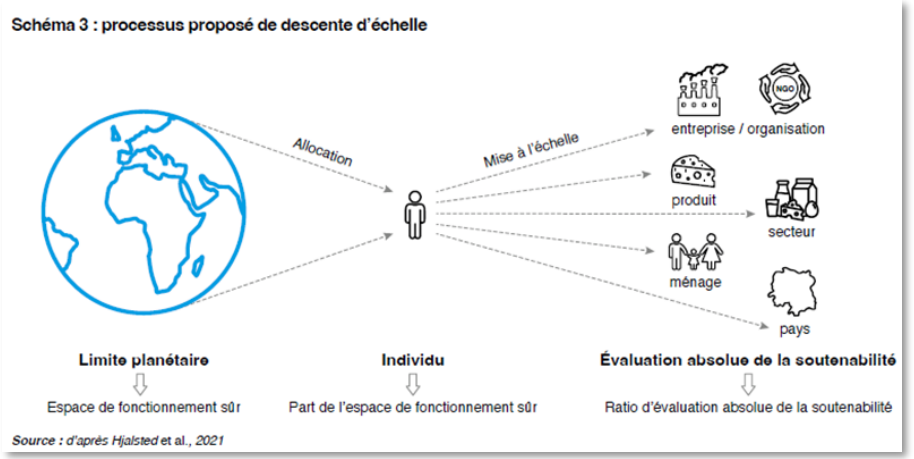
Planetary boundary weighting (PBW) 2

- Does not change the nature of LCA, which is steel relative and not absolute
- Minor changes in how LCA results are interpreted: selection of indicators and single score as gross result
- Useful for monitoring product performance, with a single score that takes greater account of planetary boundaries but sometimes results in a lower score!

IMPACT	WEIGHING VALUE	UNIT
Climate Change	25.497%	dimensionless (%)
Water Scarcity	1.397%	dimensionless (%)
Freshwater Ecotoxicity	2.314%	dimensionless (%)
Freshwater Eutrophication	8.778%	dimensionless (%)
Marine Eutrophication	1.500%	dimensionless (%)
Water Acidification	1.449%	dimensionless (%)
Fossil & Mineral Resources Depletion	11.125%	dimensionless (%)
Land Transformation	25.427%	dimensionless (%)
Terrestrial Eutrophication	0.829%	dimensionless (%)
Particulate Matter	16.250%	dimensionless (%)
Toxicity via Environment	3.167%	dimensionless (%)
Ionising Radiation	0.040%	dimensionless (%)
Ozone Depletion	0.755%	dimensionless (%)
Photochemical Ozone Formation	1.471%	dimensionless (%)

Planetary boundary normalisation + scaling (AESA) 3

- Changes the nature of LCA, making it absolute
- A complex scaling process and uncertainties (consolidation of sources and data)
- Results (ratios) vary greatly depending on the allocation method used
- Enables work on a trajectory to reduce impacts, compatible with planetary boundaries and with a target to be achieved

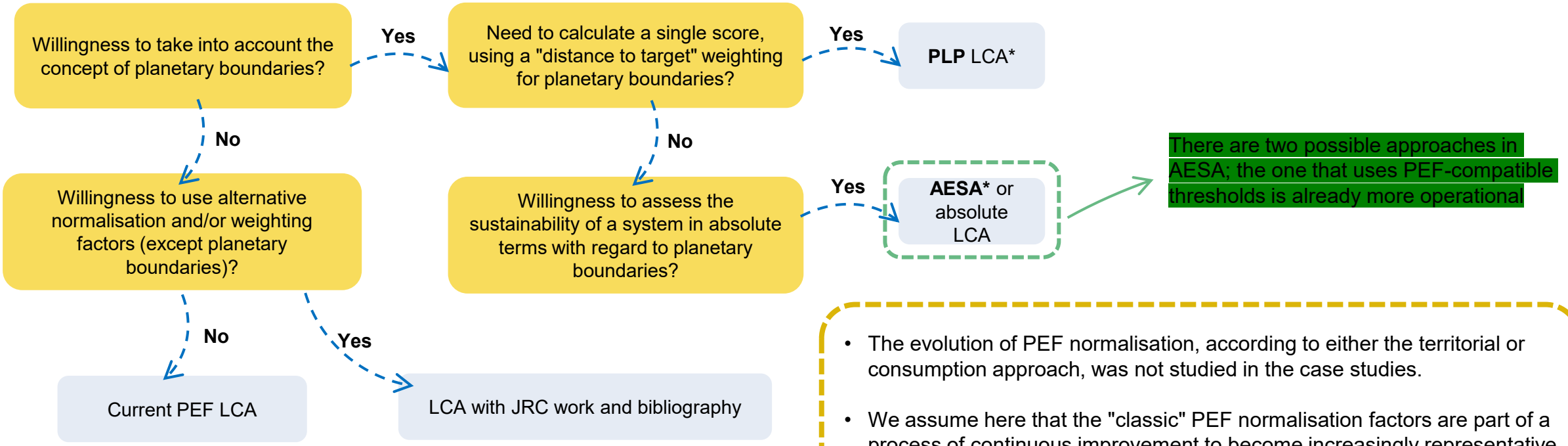


General recommendations

From the study objective to the recommended LCA type

*__AESA:__ Absolute *Environmental Sustainability Assessment*

*__PLP:__ Planetary Boundaries Weighting



There are two possible approaches in AESA; the one that uses PEF-compatible thresholds is already more operational

- The evolution of PEF normalisation, according to either the territorial or consumption approach, was not studied in the case studies.
- We assume here that the "classic" PEF normalisation factors are part of a process of continuous improvement to become increasingly representative and robust.

Merci de votre attention

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