# Weighting in the context of the EF


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**Joint Research Centre**
the European Commission's
in-house science service

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# Content

- Normalisation updates
- Overview on weighting appraoches and evaluation thereof
- Steps for developing a weighting for the EF
- Selection of the option
- Status update on implementation of the selected option
- Questions to the audience

# Normalisation

- **EU27- 2010** – issues and uncertainty
- **Global 2010** – first release provided to pilots

Next steps:

- **updated set of global factors** available soon
- Work on **planetary boundary adaptation to LCA** available soon

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**Table 3** Normalisation factor for EU 27 in 2010 for domestic emission and resource extraction, the scoring is given from I—highest to III—lowest

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| Ozone depletion | kg CFC-11 eq | 1.08E+07 | 2.16E−02 | II | III | I | Medium |
| Particulate matter | kg $PM_{2.5}$ eq | 1.90E+09 | 3.80E+00 | I | I/II | I | High |
| Photochemical ozone formation | kg NMVOC eq | 1.58E+10 | 3.17E+01 | I | II | II | Medium |
| Acidification | mol $H^+$ eq | 2.36E+10 | 4.3E+01 | I | II | II | Medium |
| Terrestrial eutrophication | mol N eq | 8.76E+10 | 1.76E+02 | I/II | I | II | Medium |
| Freshwater eutrophication | kg P eq | 7.41E+08 | 1.48E+00 | I/II | II/III | II | Medium to low |
| Marine eutrophication | kg N eq | 8.44E+09 | 1.69E+01 | II | II | II | Medium to low |
| Land use | kg C deficit | 3.78E+13 | 7.58E+04 | II/III | II | III | Low |
| Resource depletion water | $m^3$ water eq | 4.06E+10 | 8.14E+01 | III | II | III | Low |
| Mineral, fossil and renewable resource depletion | kg Sb eq | 5.03E+07 | 1.01E−01 | II | II | II | Medium |
| Human toxicity cancer | CTUh | 1.88E+04 | 3.77E−05 | III | III | II/III | Low |
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| Freshwater ecotoxicity | CTUe | 4.46E+12 | 8.94E+03 | III | III | II/III | Low |
| Ionising radiations | kBq $U_{235}$ eq | 5.64E+11 | 1.13E+03 | I | II | II | Medium |

[a] Completeness of the dataset used for the inventory. Coverage estimate based on the extent to which the inventory data are available compared to available flows in ILCD for the specific impact category. A detailed table is reported in SI. Double values reflect the fact that the coverage is depending on completeness for different compartments

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# Weighting – background

- **Weighting is not mainly natural science but inherently involves value choices** that will depend on policy, cultural and other references and value systems
- no absolute "consensus" on weighting seems could be easily reached and this is relatively inevitable in all multicriteria approaches to provide better and better implementable decision support
- the objective of JRC work is to find **a convention suitable for the EF**

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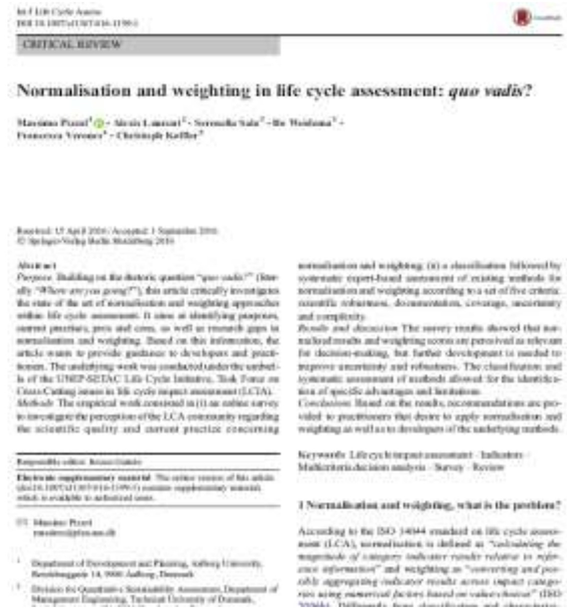
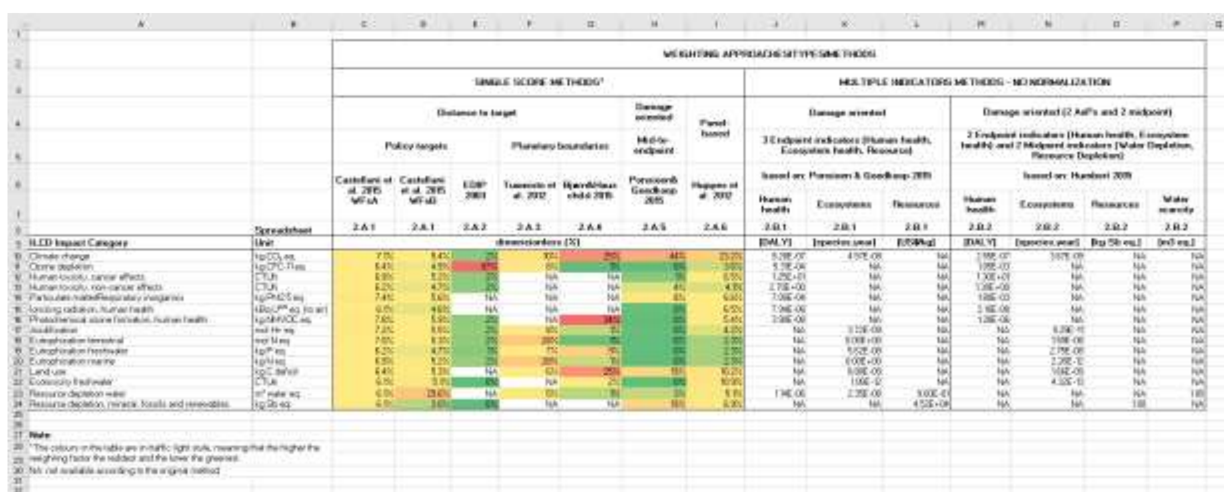
# Weighting – intermediate steps

- **Global Normalization factors** ILCD compliant;
- **Expert workshop on Weighting** together with DG ENV, Nov. 2015;
- Development of a distance to target **weighting method based on EU 2020 targets and EU27 Normalization factors**;
- **Review and evaluation of LCA weighting methods** and involvement in UNEP/SETAC LC Initiative cross-cutting issues (Pizzol et al 2016);
- Development of **Normalization and Weighting spreadsheet** for testing within the pilots (excluding monetization);

# Weighting methods

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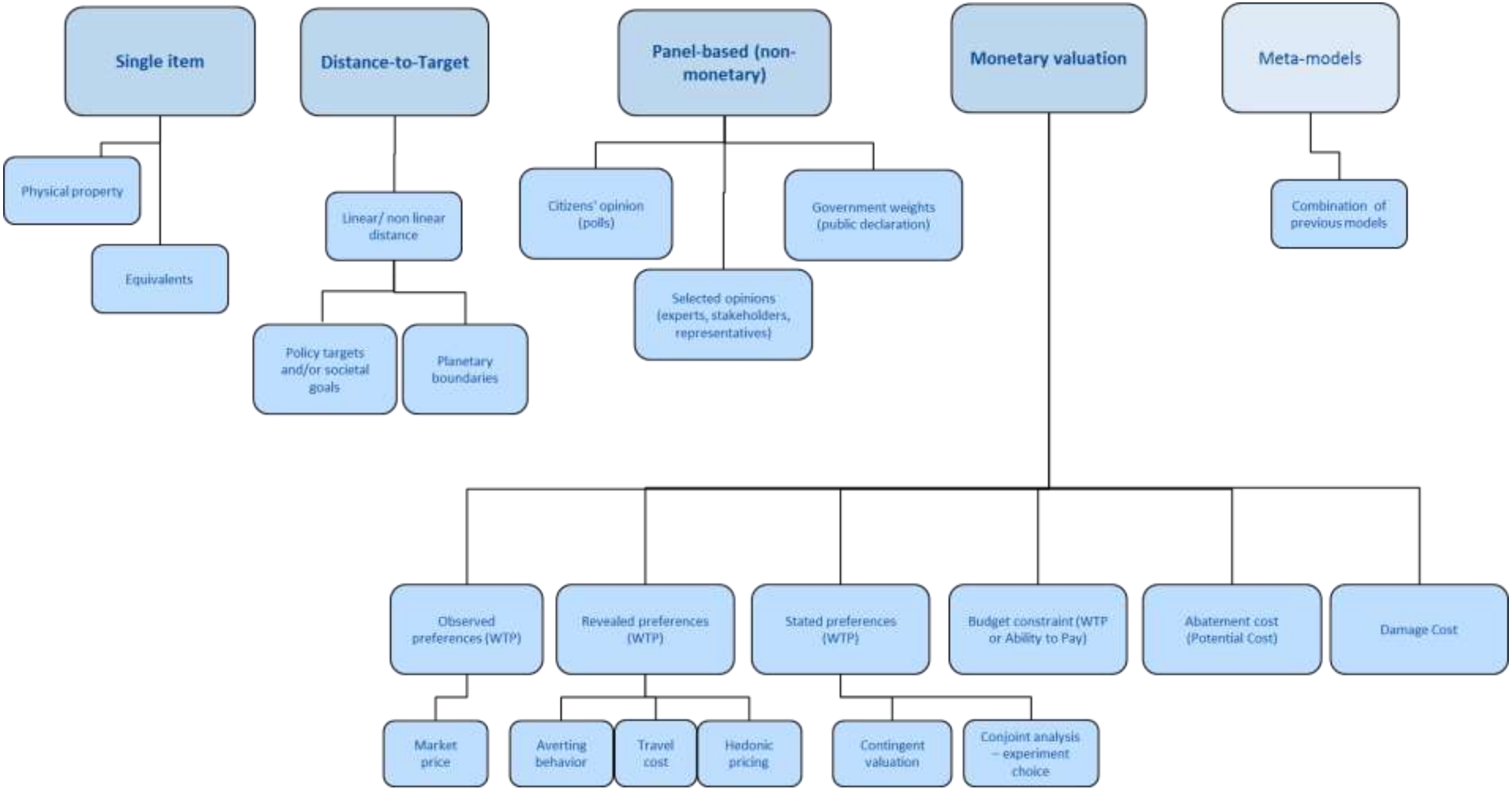

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# Weighting- results of evaluation

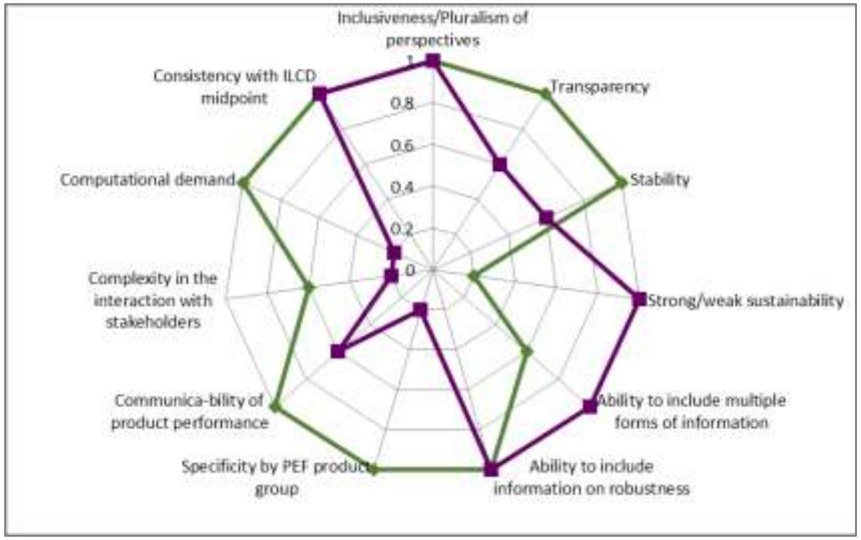
- All **weighting methods have technical pros and cons**, some are more complete than others in terms of coverage of ILCD impact categories;
- they adopt **inherently incompatible (or complementary) perspectives**;
- **Monetization is apart from a few methods limited in coverage and/or based in parts on inherent value choices**;
- **both Global normalization factors and sensitivity analysis on weighting methods are recommended within the UNEP/SETAC recommendations**;
- need for exploring combination of available perspectives as well as robustness levels

# Options for weighting

From the evaluation of the options it emerged that a promising approach could be inspired by the **metamodel of Soares et al. (2006)**

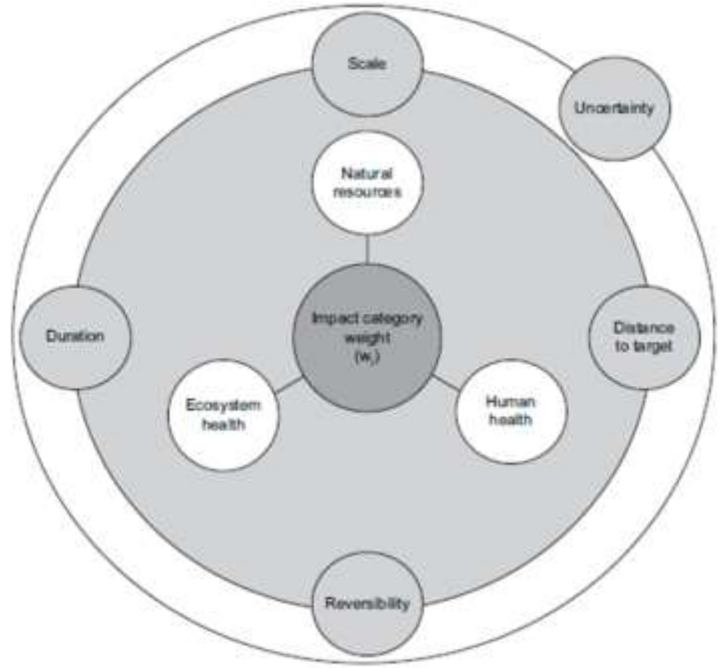
- **Four options have been developed** and presented in the report for the TAB.

- They were evaluated based on **criteria emerged from the workshop with DG ENV** in november 2015 such as: feasibility, stakeholder involvement, computational demand, consistency with ILCD midpoint indicators etc.



# Building on Soares et al 2006

- The metamodel account for aspects related to
  - **environmental relevance**, such as: **reversibility, scale, duration;**
  - **socio-political relevance**, such as: **distance to target;**
  - **scientific robustness**, such as: **uncertainty**
- Based mainly on expert judgment
- Several criteria may be considered for building a final weighting set




Assessment levels for the seven criteria

| Criteria $i$ | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Environmental consequences | Level of environmental consequences | | | | Evaluation ($e'_{i,j}$) | Certainty ($e_{i,j}$) | | |
| C1 C2 C3 | C4 | C5 | C6 | C7 | | High | Medium | Low |
| Very high repercussion | Global | Very long term | Irreversible | Far greater | 100–80 | 100 | 90 | 81 |
| Rather high repercussion | Continental | Long term | Solely artificial (partial) | Greater | 80–60 | 80 | 70 | 61 |
| Mild repercussion | National | Medium term | Solely artificial (complete) | Of the same order | 60–40 | 60 | 50 | 41 |
| Low repercussion | Regional | Short term | Natural (partial) | Smaller | 40–20 | 40 | 30 | 21 |
| Almost imperceptible | Local | Very short term | Natural (complete) | Far smaller | 20–1 | 20 | 10 | 1 |
| Non-existent | Punctual | Momentary | Natural instantaneous | Infinitely smaller | 0–1 | 0 | 1 | 1 |

# Four options

| Option | Name | Description |
|---|---|---|
| 1 | **Flat weighting at the midpoints** | Use of the characterization table for ICs based on (Soares et al. 2006) and comparison on 15 ICs in one round. Only experts in LCA can be involved. It uses weighted average as aggregation method. |
| 2 | **Weighting at the endpoints** | Use of mid-to-endpoint factors which lead to the calculation of 3 endpoint indicators, for each area of protection (human health, ecosystem quality, resources). Weights are elicited only for the endpoints and experts in LCA, EF stakeholders and public can be involved. It uses weighted average as aggregation method. |
| 3 | **Hierarchical weighting at midpoint and endpoint** | Two step procedure, establishing one set of weighting factors on the midpoint ICs clustered per endpoint and one set of weighting factors on the 3 endpoints. The two sets of weighting factors are combined in an overall scheme. For the weighting at midpoint level, several options exist, amongst others inspired by Soares et al 2006. Experts in LCA, EF stakeholders and public can be involved. It uses weighted average as aggregation method. |
| 4 | **Outranking matrix** | Use of the characterization table for ICs based on (Soares et al. 2006) and comparison on ICs clustered per endpoint. Experts in LCA, EF stakeholders and public can be involved. It uses a partially-compensatory method. |

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# Selected option (3) :
# Hierarchical weighting at midpoint and endpoint

- This option tackles the drawbacks of the other options and combines the options to reduce the preference elicitation burden on the experts as well as to include the general public and non LCA-experts from EF stakeholders.

- Two-step procedure, establishing one set of weighting factors on the midpoint ICs clustered per endpoint and one set of weighting factors on the 3 endpoints.

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# Key features of the selected option

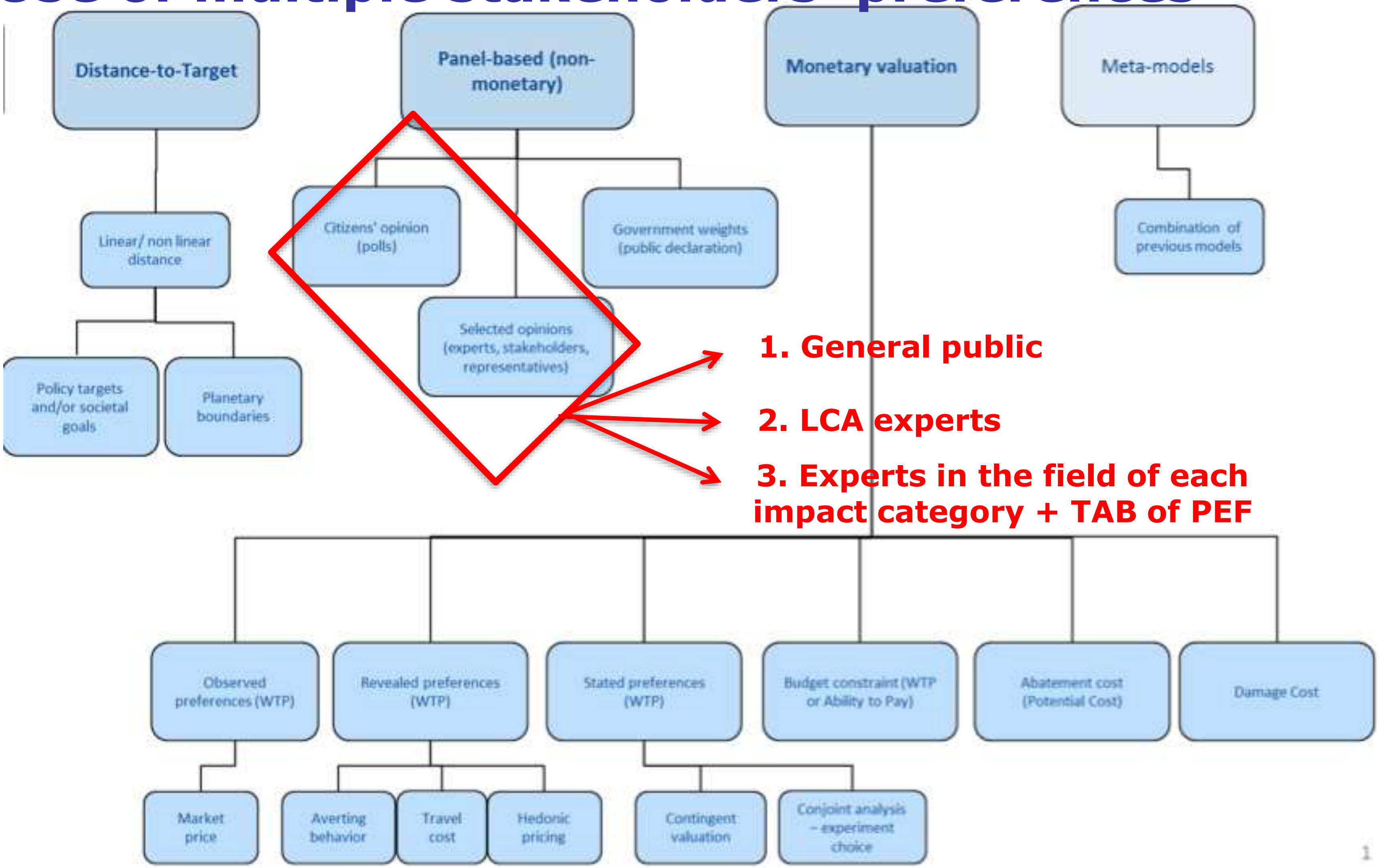
Two sets of weighting factors are combined in an overall scheme.

For the weighting at midpoint level, several options exist, amongst others inspired by Soares et al 2006.

Experts in LCA, EF stakeholders and public can be involved.

| Endpoint | Midpoint |
|---|---|
| Human Health | Climate change<br>Ozone depletion<br>Human toxicity, cancer effects<br>Human toxicity, non-cancer effects<br>Ionizing radiation, human health<br>Particulate matter/Respiratory inorganics<br>Photochemical ozone formation, human health |
| Natural Environment | Acidification<br>Climate change<br>Ecotoxicity freshwater<br>Eutrophication terrestrial<br>Eutrophication freshwater<br>Eutrophication marine<br>Land use<br>Resource use: water |
| Natural Resources | Climate change<br>Land use<br>Resource use: water<br>Resource use: metals and minerals<br>Resource use: fossil fuels |

# Use of multiple stakeholders' preferences



# Implementation strategy of the option 3

- Questionnaire for the public on midpoint and endpoint indicators → **Weighting set at mid and endpoint**
- Questionnaire for the LCA experts on midpoint and endpoint indicators → **Weighting set at mid and endpoint**
- Webinar with impact assessement experts providing input on the criteria based on Soares for each of the midpoint categories → **Weighting set related to Soares's criteria**

# Questionnaires

Two different target groups have been approached using questionnaires:

- the **general population** online panel of a representative sample

> During the life cycle of products resources and energy are used and emissions into air, water and soil are created leading to negative impacts on our health, our environment and the future availability of resources. We would like you to order these three impacts in terms of seriousness or concern to you.
>
> Please give the one which is of most concern to you a rank of 1. Then give a rank of 2 to the impact that is of the next highest concern and a rank of three to the final impact.
>
> - ... damages your health ☐
> - ... damages your environment ☐
> - ... uses resources ☐

- and **LCA experts** (through JRC's mailing list, public LCA mailing lists, social networks)

Supported by open evidence and London school of economics (LSE)

# Process for the web-based questionnaire

- Step 1 respondents swing the weightings of the three end points:
  - Most relevant end-point is set to 100 points
  - participants then have to rate the other 2 endpoints relative to the most relevant one
- Step 2 comprises the ranking of the mid points:
  - Participants are asked to select the most relevant mid-point of the top endpoint they selected in step 1.
  - Following the same logic applied in Step 1, the most relevant mid-point gets 100 points and the others are rated relative to number 1.

# Status update: General public survey

- random sample of ~400 individuals from 6 countries: Germany, Italy, Spain, UK, Poland, France
- Total of ~2400 responses achieved
- Gathering the data across countries made it possible to ensure the validity and possibility to generalise about awareness and understanding of the impact categories as well as about the broader environmental awareness
- Survey is closed (Jan 18), results are in and are about to be evaluated

# Status update: LCA experts survey

- 5820 experts were invited (mainly via existing LCA related email lists)
- 1053 opened the questionnaire
- 518 completed the questionnaire
- Survey is closed (Feb 13), results are in and are about to be evaluated

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# Status update: Soares inspired survey of impact assessment related experts

- ~ 600 people invited (on Feb 17) to participate
- People involved in LCIA related research activities, LCIA method developers, experts in the impact categories, EF TAB members
- 2 different dates for webinar are on offer (Feb 28, March 1)
- Questionnaire to be filled in during the webinar or latest by March 3
- Input requested on science based aspects for each of the impact categories as well as on the weighting of the different aspects

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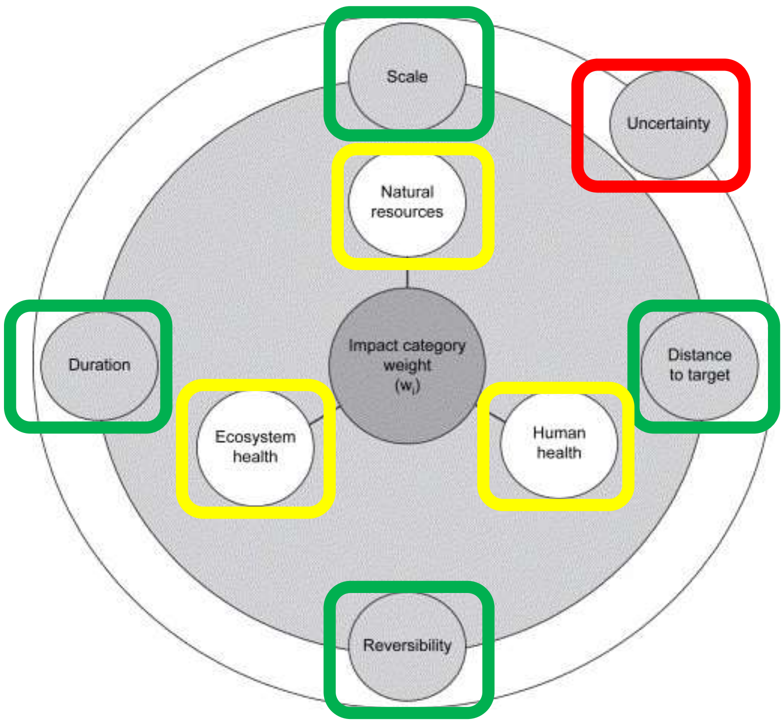
# Table for experts inspired by Soares approach

Used in webinar with impact assessment experts

| Impact category | Scale of impacts | Spread of pressure | Duration of impact | Reversibility | Planetary boundary | Effect on human health | Effect on ecosystem quality | Effect on resources availability |
|---|---|---|---|---|---|---|---|---|
| Climate change | Global | Globally present | Very long term | Natural (partial) | Greater | High | Low | Medium |
| Ozone depletion | Global | Highly diffused | Medium term | Natural (complete) | Far smaller | Very high | High | Not-existing |
| Human toxicity, cancer effects | Global | Widespread | Very long term | Irreversible | Greater | Very high | Not-existing | Not-existing |
| Human toxicity, non-cancer effects | Global | Widespread | Long term | Solely artificial (partial) | Of the same order | Very high | Not-existing | Not-existing |
| Particulate matter/Respiratory inorganics | Local | Widespread | Long term | Solely artificial (partial) | Greater | High | Not-existing | Not-existing |
| Ionizing radiation, human health | Global | Little diffused | Very long term | Irreversible | Of the same order | Very high | Low | Not-existing |
| Photochemical ozone formation, human health | Local | Medium diffused | Long term | Solely artificial (partial) | Of the same order | High | Low | Not-existing |
| Acidification | Regional | Highly diffused | Medium term | Natural (partial) | Far smaller | Not-existing | High | Medium |
| Eutrophication terrestrial | Regional | Highly diffused | Medium term | Natural (partial) | Far greater | Not-existing | High | Medium |
| Eutrophication freshwater | Regional | Highly diffused | Medium term | Natural (partial) | Far greater | Not-existing | High | Medium |
| Eutrophication marine | Regional | Medium diffused | Medium term | Natural (partial) | Far greater | Not-existing | High | Medium |
| Land use | Local | Little diffused | Long term | Natural (partial) | Of the same order | Not-existing | Very high | High |
| Ecotoxicity freshwater | Global | Little diffused | Long term | Solely artificial (partial) | Far greater | Not-existing | Very high | High |
| Resource depletion water | National | Little diffused | Medium term | Solely artificial (partial) | Far smaller | Very high | Very high | Very High |
| Resource depletion, mineral | Global | Little diffused | Very long term | Irreversible | n.a. | Low | High | Very High |
| Resource depletion, fossils | Global | Little diffused | Very long term | Solely artificial (partial) | n.a. | Low | High | Very High |

# Option 3c: Inclusion of aspects from Soares

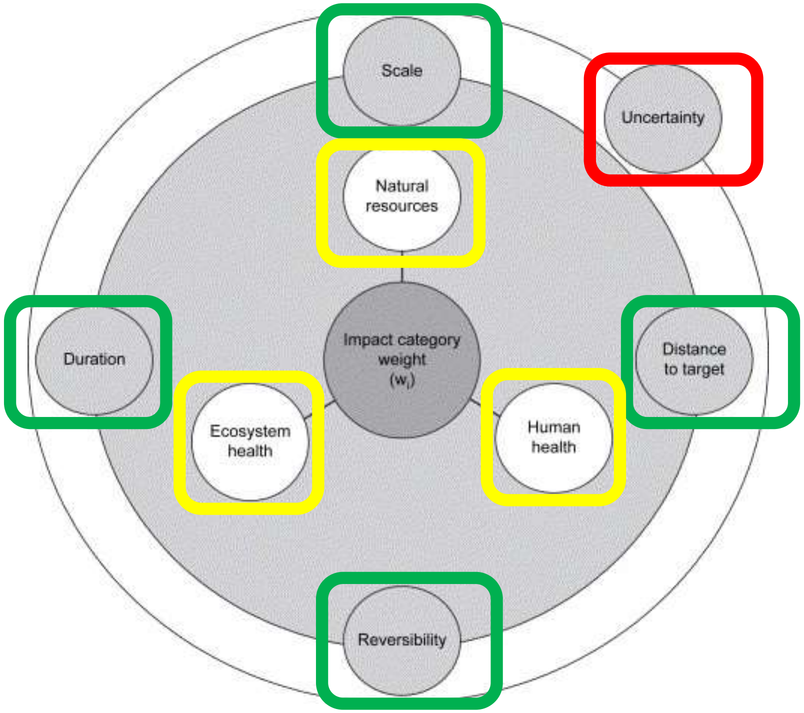



- **Expert weighting based on the scoring of the criteria (via webinars)**

- **Captured by weighting of endpoints (based on questionnaires)**

- **Captured by the robustness factors in interpretation or to be assessed by experts in webinar**

# Option 3d: Inclusion of aspects from Soares




- Embedded in the planetary boundaries concept, used for normalisation

- Captured by the two levels weighting approach (midpoint/ endpoint) based on questionnaires (to public/experts)

- Captured by robustness factors in interpretation

# Linking the bits and pieces I

Different combinations of the results from the Soares based approach with other aspects are possible...

## Normalisation

Global

## Weighting

| Planetary boundaries as distance to target | Public and expert elic itation | Uncertainty of LCIA models |
| --- | --- | --- |

# Linking the bits and pieces II

Different combinations of the results from the Soares based approach with other aspects are possible...

| Normalisation | Weighting | Robustness factors (interpret.) |
|---|---|---|
| Planetary boundaries as normalisation | Public and expert elicitation | LCIA models and normalisation robustness/ data availabiity |

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# Building on a table assessing the uncertainties of LCIA/normalisation/ inventory

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[a] Completeness of the dataset used for the inventory. Coverage estimate based on the extent to which the inventory data are available compared to available flows in ILCD for the specific impact category. A detailed table is reported in SI. Double values reflect the fact that the coverage is depending on completeness for different compartments

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# Weighting – questions to the audience I

## What is the most appropriate approach?

- Is the planetray boundaries concept 'fit for purpose' as normalisation or should it be – as distance to target – form a part of the weighting?
- Should uncertainty of LCIA models be a part of weighting step or should it be together with robustness of normalization factors and kept for the interpretation?
- In a comparative context: would you base your decision for or against a product rather on differences which are robust or on differences in impact categories with high uncertainty?

# Weighting – questions to the audience II

- Does the relevance of the midpoint categories for the endpoints human health, ecosystem health, and natural resources sufficiently describe their severity?
- Or should severity be assessed as one of the weighting parameters independant from the 3 endpoints?

# Weighting – questions to the audience III

## What is the most appropriate approach?

- What is the best way (if any) to combine the resulting weighting sets from
  - **Public (midpoint and endpoint questionnaire)**
  - **LCA experts (midpoint and endpoint questionnaire)**
  - **Impact assessement experts (inspired by Soares approach)**
- Or should the 3 weighting sets remain separated and the decision which one to choose left to decision makers?

In any case what we will provide is an input to decsion makers, the decsion on a weighting approach will be taken by policy makers

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