CERIS Civil Engineering Research and Innovation for Sustainability

TÉCNICO LISBOA

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Economic valuation of life cycle environmental impacts of construction products - A critical analysis

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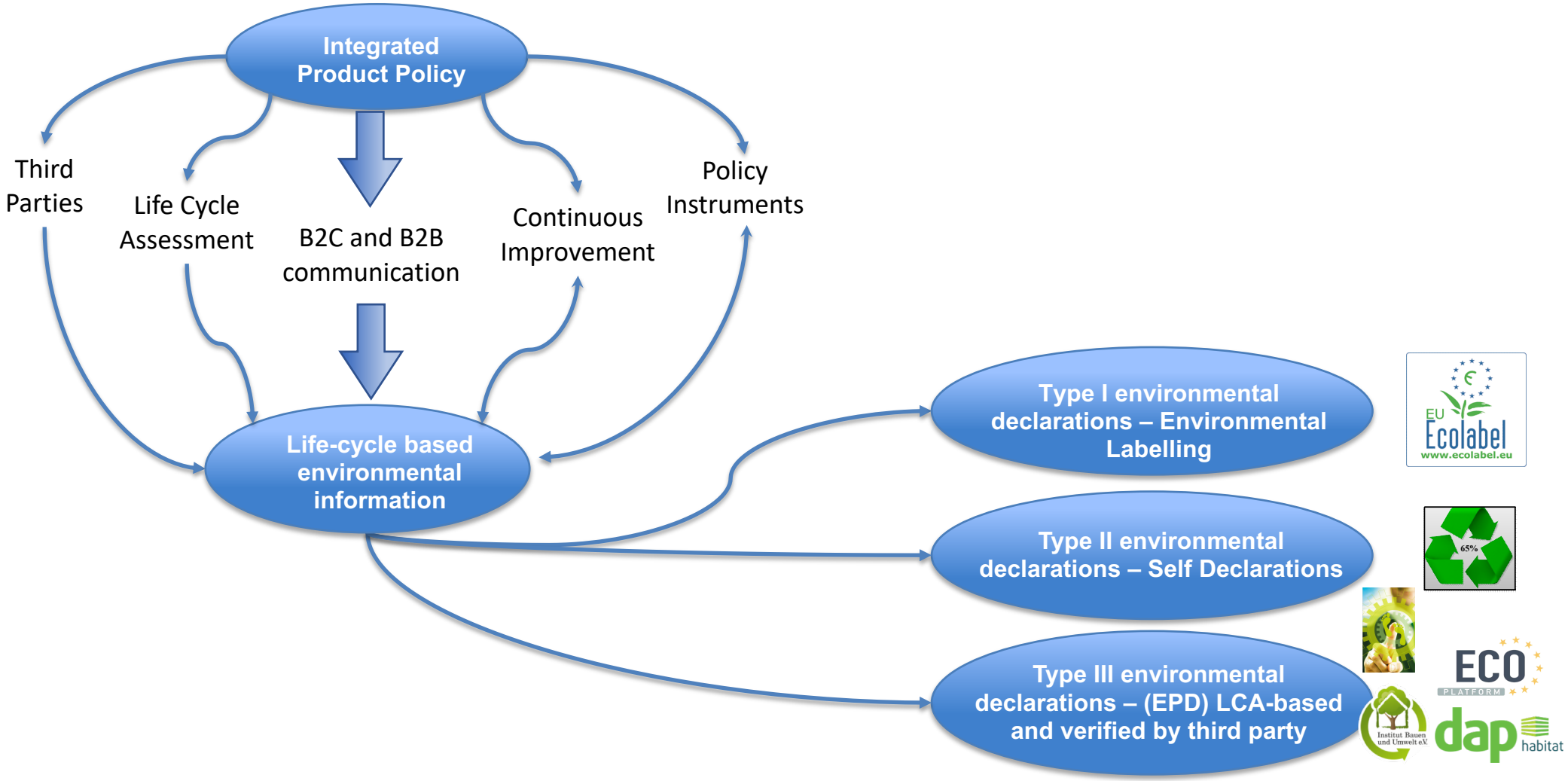
1. Motivation

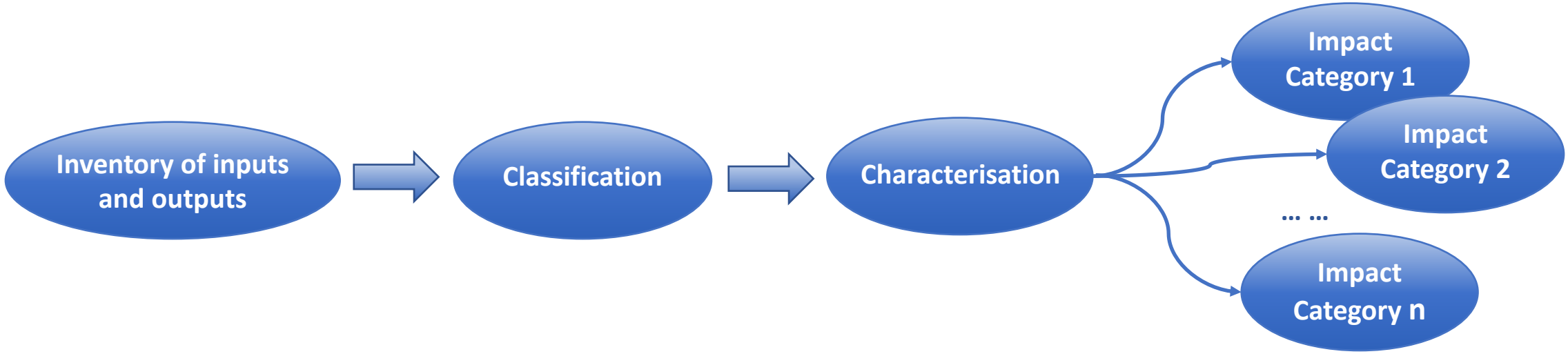
- Relevance of the building sector in: a) Economy, jobs; b) resource consumption and emissions (potential environmental impacts); c) High (environmental) saving potential;
- Increasing willingness of stakeholders for the consideration of environmental aspects → need for objective and independent information on the environmental performance of construction products;
- Existence of LCA-based labels and declarations with distinct levels of reliability and based on different scopes and boundaries of the LCA study.

2. Background



3. Monetisation

- Life cycle assessment study:



3. Monetisation

- Impact categories used in PEF impact assessment method:
  - **16 environmental impact categories** (plus several other parameters related to resource use and outputs).

Source: PRé Sustainability, 2019, adapted from European Commission: https://ec.europa.eu/environment/eussd/smgp/communication/impact.htm

3. Monetisation

- Impact categories currently used in EPDs impact assessment method (CML):
  - **7 environmental impact categories** (plus several other parameters related to resource use and outputs).

- Many categories with different results expressed in distinct units!
- Which are the most relevant/ important? → WEIGHTING

3.1. Monetisation approaches

- Monetisation expresses the relative importance of an impact category in monetary value

Approach	Description
Revealed willingness to pay	• **Market prices** (damage costs: loss of production, loss of capital or added value) • **Revealed preference** methods (productivity method and travel cost method) • **Hedonic pricing** (combining market prices of a good and the influence of environmental aspects on the user's willingness to pay)
Expressed willingness to pay	• **Stated preference** methods (contingent valuation and choice modelling)
Imputed willingness to pay	• **Damage cost avoided** method (e.g. restoration costs, remediation costs, defensive expenditures) • **Replacement cost** method uses the cost of replacing an ecosystem or its services • **Substitute cost** method uses the cost of providing substitutes for an ecosystem or its services
Political willingness to pay	• Costs-to-reach-**target** • **Taxes**
Avoidance costs	• Estimation of the **cost to limit some emissions or impacts** to a chosen limit, based on a hypothetical situation and not on willingness to pay

3.2. Identified monetisation methods (1)

Method	Approach	Environmental information used
Eco-costs	Revealed willingness to pay - Market prices (prevention prices)	Results of **CML** Baseline midpoint impact categories
Ecotax 2002	Political willingness to pay - Taxes	Results of **CML** Baseline midpoint impact categories
Ecovalue 08	Revealed willingness to pay - Market prices (added value) and imputed willingness to pay - Damage cost avoided method (defensive expenditures)	Results of **CML** Baseline midpoint impact categories
Environmental Prices	Revealed willingness to pay - Market prices (prevention prices)	Close to the **ReCiPe** method, with additional nuisance-related category
Environmental Priorities Strategies in product design (EPS)	Imputed willingness to pay - Damage cost avoided method (defensive expenditures)	15 impact categories, as defined in the **EPS 2000 life cycle impact assessment method**

3.2. Identified monetisation methods (2)

Method	Approach	Environmental information used
External costs of energy (ExternE)	Revealed willingness to pay - Market prices (added value)	**Project specific** impact assessment method applied for socio-environmental damages caused by distinct energy carriers
LIME	Expressed willingness to pay - Stated preference methods	**11 impact categories:** urban air pollution, hazardous chemicals, eutrophication, global warming, ecotoxicity, acidification, ozone layer depletion, photochemical oxidant creation, land use, waste, and resource consumption
Social Cost of Carbon	Revealed willingness to pay - Market prices (damage costs: loss of welfare)	**Global warming potential**, measured in CO2eq
Stepwise 2006	Imputed willingness to pay - Damage cost avoided method (defensive expenditures)	Results of I**MPACT2002+ v. 2.1** and the **EDIP2003** impact assessment methods

3.3. Compatibility with EPD information

Is the method compatible with EPD provided information?

YES:

- Eco-costs
- Ecotax 2002
- Ecovalue 08
- Social Cost of Carbon

NO:

- Environmental Prices
- EPS
- ExternE
- LIME
- Stepwise 2006

3.4. Examples of application: Case studies in the construction sector

- Examples for Eco-costs method

- **Reference:** Scheepens et al, 2018
- **Objective:** analysis of cost, (market) value, and eco-burden to compare passive (insulation focused) and active (behaviour focused) solutions.
- **Results:** identification of the economic and environmental payback and the likelihood for potential rebound effects.

- **Reference:** Carreras et al, 2016
- **Objective:** translation of the environmental impact of the building envelope into monetary units, for economic performance assessment.
- **Results:** optimisation of the thermal insulation of a building envelope in different climate zones.

3.4. Examples of application: Case studies in the construction sector

- Examples for Ecotax 2002 method

- **Reference:** Du et al, 2018
- **Objective:** application of Ecovalue08 and Ecotax02 methods to evaluate the environmental costs of distinct design options.
- **Results:** comparison of the environmental performance of two bridge types through the whole life cycle.

- **Reference:** Huysegoms et al, 2018
- **Objective:** application of different monetization methods of LCA results in social cost-benefit analysis (CBA)
- **Results:** obtention of a more detailed overview and valuation of the secondary environmental effects.

4. Conclusions

- LCA is an important methodology for calculating and communicating environmental performance of products, but it delivers too complex information, even in EPDs, produced for B2B communication;
- Weighting of LCA results in the form of monetisation of environmental impacts provides a single indicator in an objective unit, allowing professionals to evaluate and easily compare options while being aware of the magnitude of environmental impacts in each life cycle stage (in relation to market costs of a project);
- Several monetisation methods are available but only Eco-costs, Ecovalue 2008, Ecotax 2002 and Social Cost of Carbon are compatible with EPDs results;
- There is a need for further development/improvement of monetisation methods;
- It would be important to have a monetisation method that can be Europe-wide representative as well as easily applicable to the available information, for instance, EPDs or other standardised sources of LCA information (e.g., Product Environmental Footprints – PEF);
- Standards and guidelines for EPDs and PEFs should include the option of weighting the LCA results through monetisation, providing the common user with an easier to interpret and more tangible information in what relates to the potential life cycle environmental impact of a product.

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REPÚBLICA PORTUGUESA

FCT Fundação para a Ciência e a Tecnologia

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