Tools to minimise the environmental impact of buildings

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UCLouvain - LAB

PRESENTATION OF THE SPEAKERS

Emilie Gobbo trained as an architect for several years before joining UCLouvain to conduct a doctoral thesis and then, post-doc to study the Brussels' urban stocks and the impacts of energy retrofit on material stocks and flows from a circular economy perspective. At Bruxelles-Environnement, she then worked on the Interreg NWE-FCRBE project aimed at facilitating the circulation of reclaimed building elements in north-west Europe. She is also working on the deployment of the circular economy axis in the RENOLUTION regional renovation strategy. In September 2023, she joins UCLouvain, the LOCI Faculty and the Lab Institute as an associate professor.

Dorothée Stiernon is an architect (ULB, 2012) and holds a Master's degree in Environmental Science and Management (UCLouvain, 2014). After practicing in Switzerland and in Brussels, she joined the Louvain research institute for Landscape, Architecture, Built environment (LAB - UCLouvain, 2016). Her research projects and PhD focus mainly with the challenge of renovating old buildings with heritage value, linked to energy and environmental issues, recognized today as imperative and unavoidable. She is co-author of the book Isolants thermiques en rénovation (EPFL PRESS, 2023) and is also involved as a teaching assistant on the Faculty of Architecture, Architectural Engineering and Urban Planning (LOCI - UCLouvain, 2017).

The presentation aims to give a quick overview of design and decision support tools at different building scales, with the aim of reducing the environmental impact of the construction sector. Emphasis will be placed on the Belgian TOTEM tool for assessing environmental performance from material to building level.

PRESENTATION OBJECTIVES

Discuss **design** and **decision support tools** at different building scales with the aim of reducing the environmental impact of the construction sector.

A focus will be placed on the belgian **TOTEM tool** which makes it possible to assess environmental performance from material to building level.

CONTENTS

I. WHY?

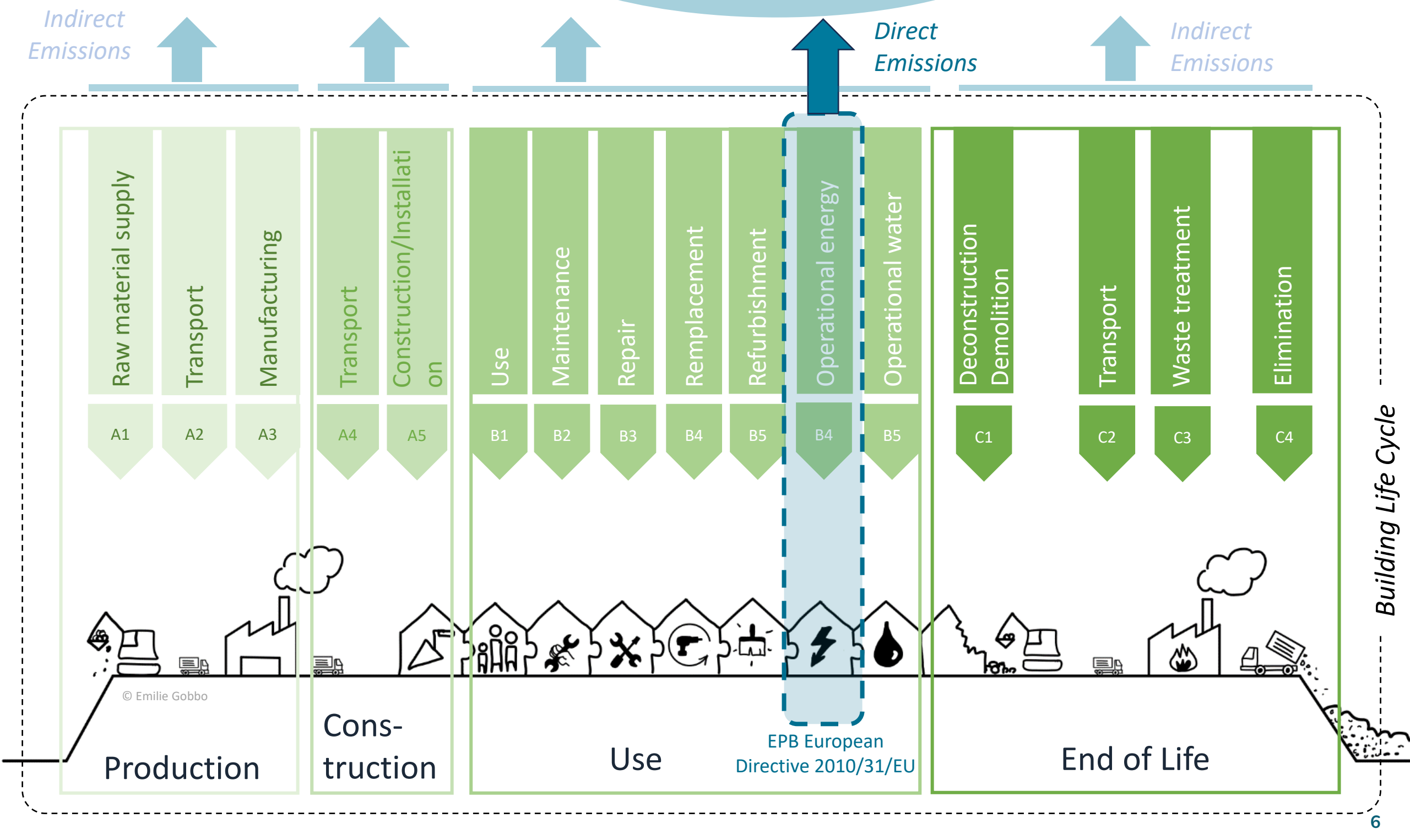
Buildings are responsible for:
50% of the materials used; **40%** of CO_2 emissions;
36% of waste produced

- The construction sector has been identified as a key area for action to reduce environmental impact.

Source : FCRBE Project

I. WHY?

Environmental & Sanitary Impacts



I. WHY?

Sources: ECORES, BATIR, 2015; Circular Buildings Coalition, 2023; European Waste Statistics, 2019

Brussels Urban Stock

185 billion tonnes

(84% = buildings and 15% = infrastructures)

New Materials

1,094,000 kt
(construction & renovation for EU27+UK)

Renovation of the Building stock

C&D Waste

923,670 kt
(construction & renovation for EU27+UK)

In Flows

Out Flows

If current renovation practices continue as usual, renovation activities will consume 918 million tonnes of virgin materials between 2022 and 2050, resulting in 978 million tonnes of GHG emissions.

II. WHICH TOOLS?

Architects generally play an **important role** in the choice of materials used in a construction project. Their decisions can have a major influence on the **building's impact on the environment**.

Various tools have been developed to help them make such decisions:

- **Decision support tools** to **Assessment tools**
- **Different scales covered** (materials, components, buildings).
- **Different phases covered** (early design stages to building complation)

These environmental impact tools are generally **based on an LCA approach**. They often have to find a compromise between user-friendliness and consistency of information.

II. WHICH TOOLS?

Tools used & developed in Belgium & in the Brussels Capital Region

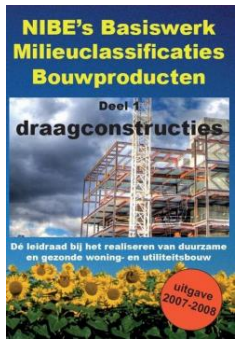
Ecolabels	Environmental classification and rating tool	Environmental Product Declaration (EPD)	Guidance Tools	Assessment Tools

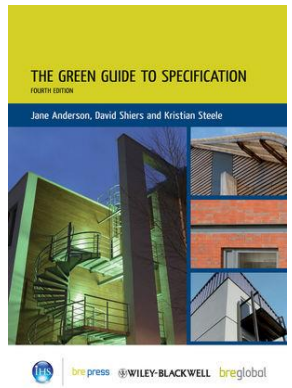
EU Ecolabel www.ecolabel.eu

Produit Biosourcé

natureplus® No. 0000-0000-000-0

DER BLAUE ENGEL JURY UMWELTZEICHEN schützt MENSCH und UMWELT





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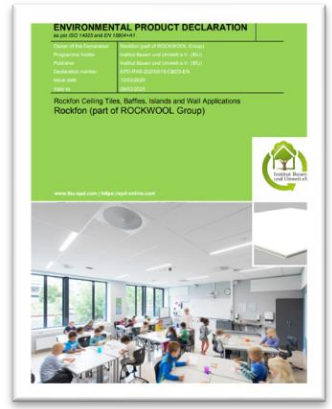
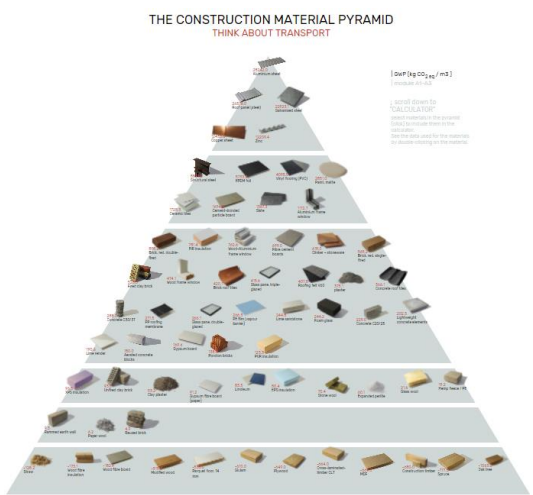


EPD®

inies

ecoinvent



FSC

PEFC™

NORDIC SWAN ECOLABEL

CERTIFIED CM cradletocradle

ecobau

Ecobau définit des standards pour une construction saine et durable en Suisse.

CRTI·B
CENTRE DE RESSOURCES DES TECHNOLOGIES ET DE L'INNOVATION POUR LE BÂTIMENT

GUIDE BÂTIMENT DURABLE .brussels

Reversible Design Checklist/Guide Tools

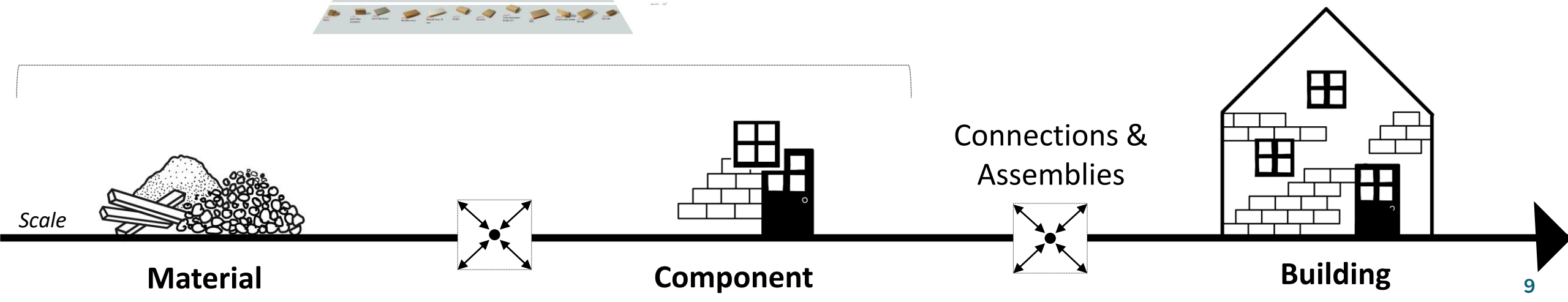
elodie

MilieuPrestatie Gebouwen

MPG.

totem
CREATE | EVALUATE | INNOVATE

GRO



III. TOTEM TOOL

III. TOTEM TOOL

- Scales and database

SCORE

Product Environmental Footprint method

(in Milli Points)

= Sum of the various indicators weighted into a single score

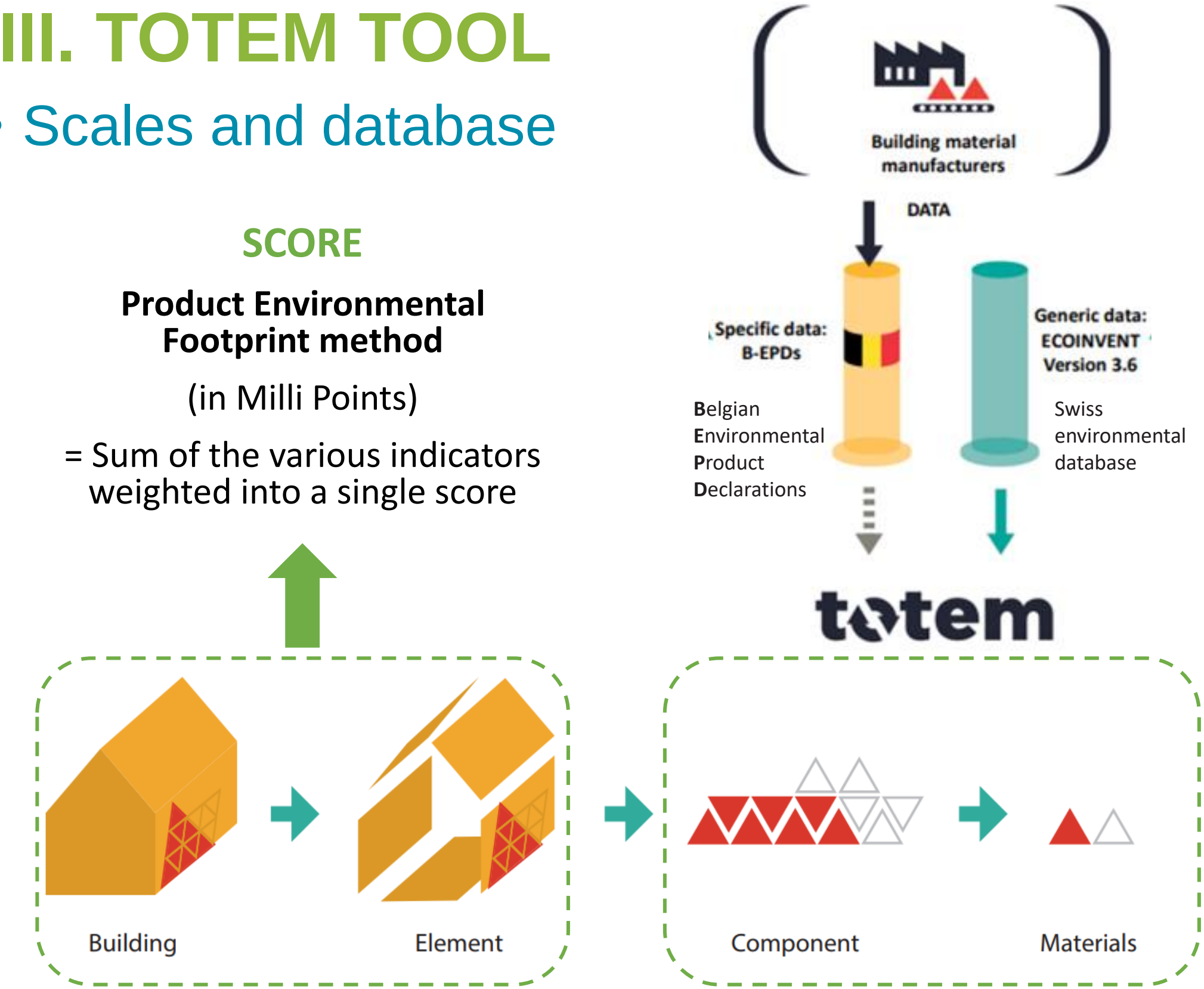


Figure 1: Illustration of the hierarchical structure of TOTEM and its four levels of analysis.

III. TOTEM TOOL

- Environmental Indicators

19 environmental impact indicators grouped into 12 main categories

Milli Points

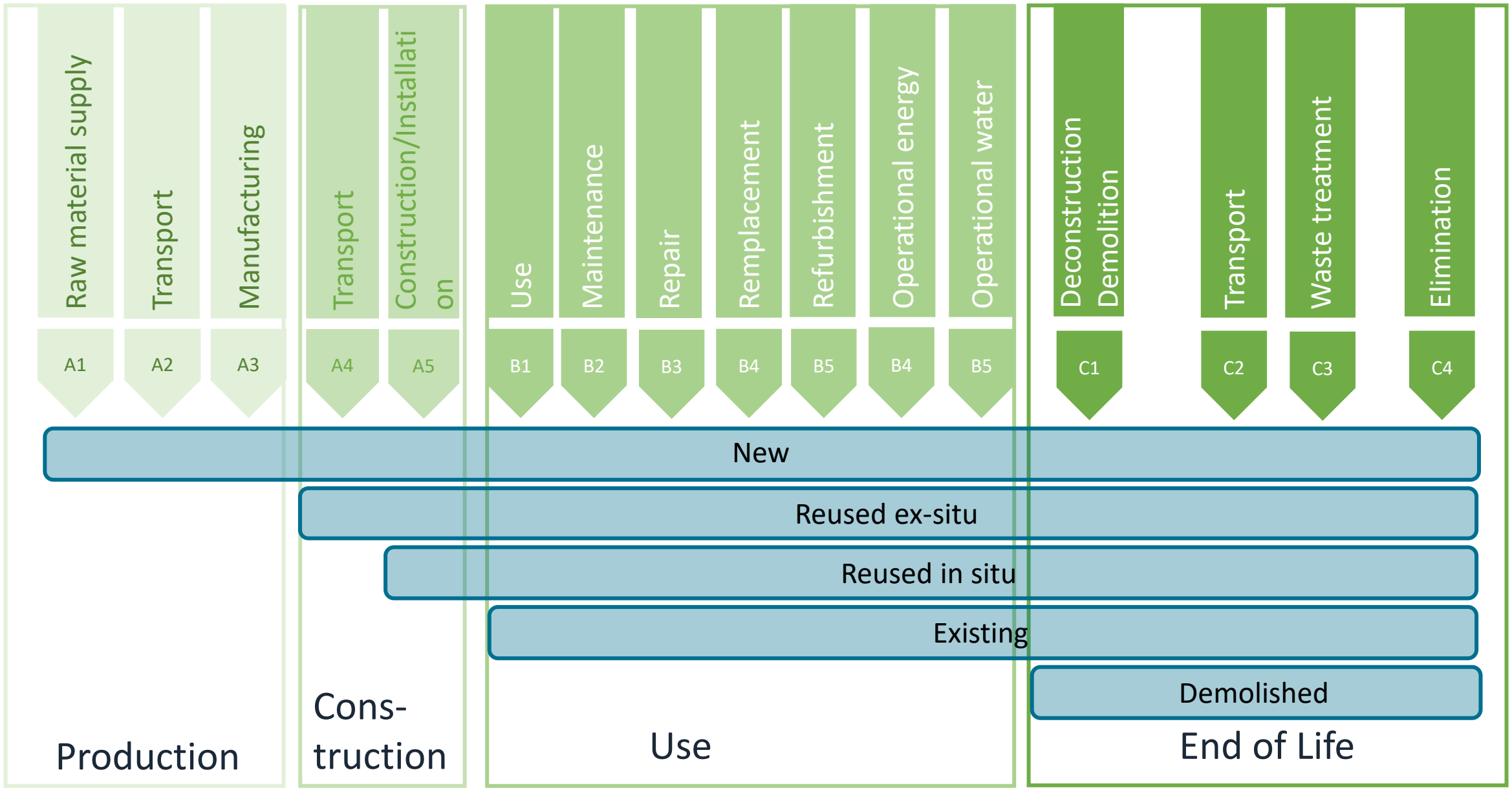
Environmental impact indicators							
Impact indicator		Impact value (per m²UFA)	Calculation unit	Aggregation factor		Environmental score	
						mPt/m²UFA	%
	Climate change	6521	kg CO2 eq.	0.026	mPt/kg CO2 eq	170	45%
	Climate change - fossil	6512	kg CO2 eq.	0.026	mPt/kg CO2 eq	169	45%
	Climate change - biogenic	5.9	kg CO2 eq.	0.026	mPt/kg CO2 eq	0.15	0.04%
	Climate change - land use and land use change	2.2	kg CO2 eq.	0.026	mPt/kg CO2 eq	0.059	0.016%
	Ozone Depletion	0.00091	kg CFC 11 eq.	1176	mPt/kg CFC11 eq	1.1	0.28%
	Acidification	12	mol H+ eq.	1.1	mPt/mol H+ eq	13	3.5%
	Eutrophication					10	2.8%
	Eutrophication aquatic freshwater	0.044	kg P eq.	17	mPt/kg P eq	0.77	0.2%
	Eutrophication aquatic marine	2.5	kg N eq.	1.5	mPt/kg N eq	3.8	1%
	Eutrophication terrestrial	28	mol N eq.	0.21	mPt/mol N eq	5.9	1.6%
	Photochemical ozone formation	9.6	kg NMVOC eq.	1.2	mPt/kg NMVOC eq	11	3%
	Depletion of abiotic resources					118	31%
	Depletion of abiotic resources - minerals and metals	0.0028	kg Sb eq.	1186	mPt/kg Sb eq	3.3	0.89%
	Depletion of abiotic resources - fossil fuels	89682	MJ, net calorific value	0.0013	mPt/MJ	115	30%
	Water use	400	m3 world eq. deprived	0.0074	mPt/m3 depriv.	3	0.79%
	Particulate Matter emissions	0.00016	Disease incidence	150528	mPt/disease inc.	25	6.6%
	Ionizing radiation, human health	98	kBq U235 eq.	0.012	mPt/kBq U-235 eq	1.2	0.31%
	Eco-toxicity (freshwater)	38477	CTUe	0.00045	mPt/CTUe	17	4.6%
	Human toxicity					6.6	1.8%
	Human toxicity, cancer effect	0.000003	CTUh	1260385	mPt/CTUh	3.7	0.99%
	Human toxicity, non-cancer effects	0.000036	CTUh	80114	mPt/CTUh	2.9	0.77%
	Land use related impacts/ Soil quality	7457	dimensionless	0.000097	mPt/Pt	0.72	0.19%
	Total					**377.05**	**100%**

Weighting

III. TOTEM TOOL

- A tool integrating circularity: continuous improvement

Different "**statuses**" for each layer

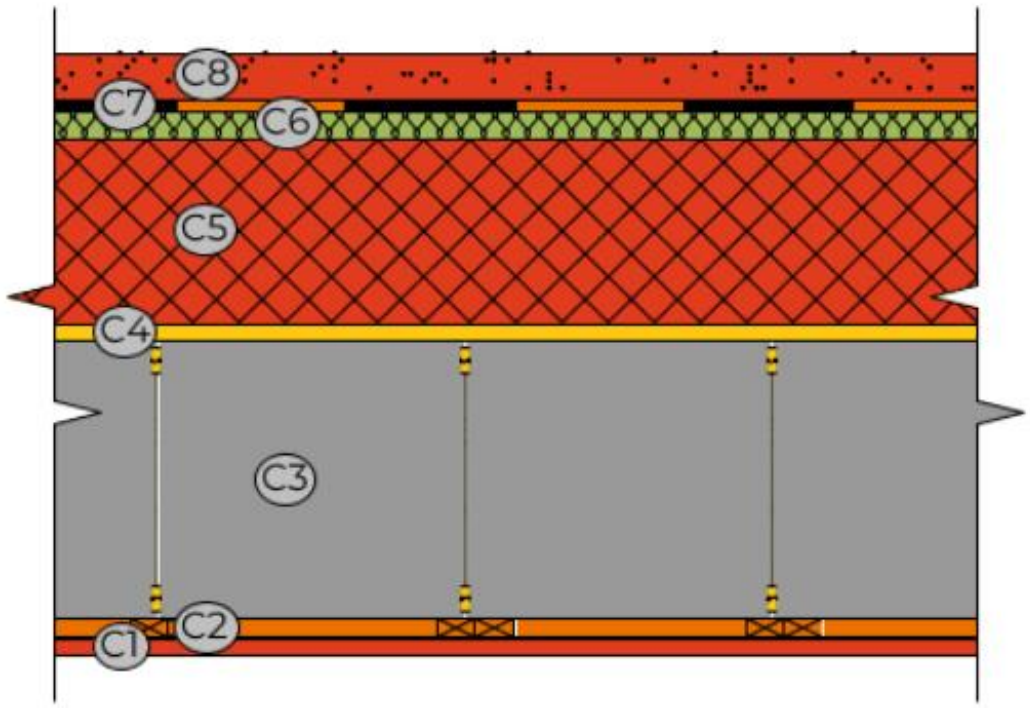


III. TOTEM TOOL

- A tool integrating circularity: continuous improvement

Example: storey floor

Qualitative assessment of **reversibility potential**, represented by a color code for each layer



Non-reversible connections

Reversible connections with non-repairable damage

Reversible connections with light repairable damage

Reversible connections

Reversible connections not applicable or depending on the applied construction method

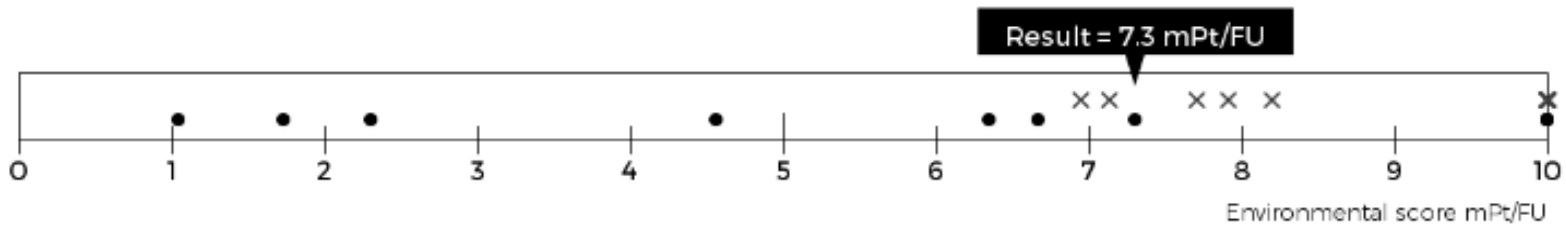
D9	Floor finish | Support structure	Screed | Reinforced cement (50 mm)	Demolished	⧖ ≥ 60 years ↕ 0.05 m	R 0.031 m²K/W
C8	Floor finish | Support structure	Screed | Reinforced cement (50 mm)	New	⧖ ≥ 60 years ↕ 0.05 m	R 0.031 m²K/W
C7	Multiple applications | Vapour barrier	Proofing sheet | PP (0.25 mm) | Stapled	New	⧖ ≥ 60 years ↕ 0.00025 m	N.A.
C6	Floor finish | Thermal insulation	Board | Stone wool (30 mm) | Upon floor slab	New	⧖ ≥ 60 years ↕ 0.03 m λ 0.036 W/mK	R 0.833 m²K/W
C5	Flat roof | Slab	Cast in situ | Reinforced concrete (200 mm)	Existing	⧖ ≥ 60 years ↕ 0.2 m	R 0.118 m²K/W
C4	Floor finish | Support structure	Board | OSB (18 mm) | Screwed	New	⧖ ≥ 60 years ↕ 0.018 m	R 0.138 m²K/W
C3		Composed layer			R 0.163 m²K/W
b. 98%	Floor | Air cavity	Not ventilated cavity | Air layer (300 mm) | 15 ≤ t ≤ 300 mm	New	⧖ ≥ 60 years ↕ 0.3 m	
a. 2%	Floor | Support structure	TJI 350 profiles | Laminated timber - OSB (300 mm)	New	⧖ ≥ 60 years ↕ 0.3 m	
C2	Ceiling finish | Support structure	Battens | Softwood (47x22 mm - c.t.c 450 mm) | Nailed | Untreated | Belgian mix	New	⧖ 30 years ↕ 0.022 m	R 0.16 m²K/W
C1	Ceiling finish | Cladding	Board | Wood fibre (18 mm) | Screwed | Including joint filler	New	⧖ 30 years ↕ 0.018 m	R 0.1 m²K/W
Total				0.63825 m	U 0.53 W/m²K

III. TOTEM TOOL

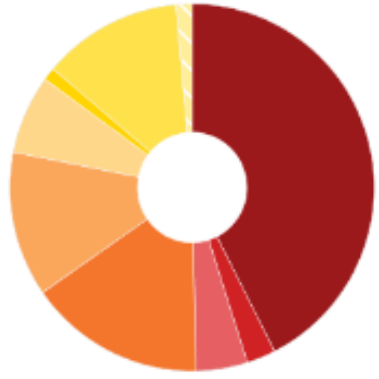
- Results: element scale

Example: storey floor

Score of the element compared to other elements within the same category in the library

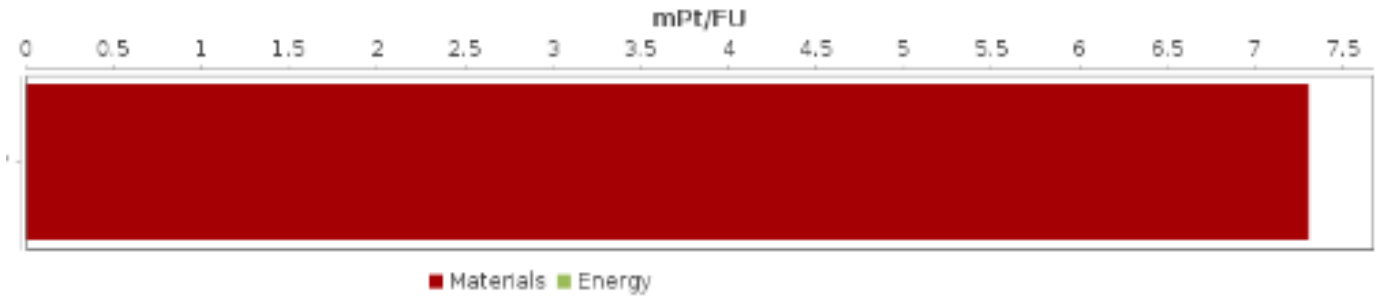


Relative material **impact per component**



- 43%: C1 Board | Wood fibre (18 mm) | Screwed | Including joint filler
- 3%: C2 Battens | Softwood (47x22 mm - c.t.c 450 mm) | Nailed | Untreated | Belgian mix
- 5%: C3a TJI 350 profiles | Laminated timber - OSB (300 mm)
- <1%: C3b Not ventilated cavity | Air layer (300 mm) | 15 ≤ t ≤ 300 mm
- 16%: C4 Board | OSB (18 mm) | Screwed
- 13%: C5 Cast in situ | Reinforced concrete (200 mm)
- 7%: C6 Board | Stone wool (30 mm) | Upon floor slab
- 1%: C7 Proofing sheet | PP (0.25 mm) | Stapled
- 12%: C8 Screed | Reinforced cement (50 mm)
- 1%: D9 Screed | Reinforced cement (50 mm)

Materials vs. Operational **energy** use for heating impact



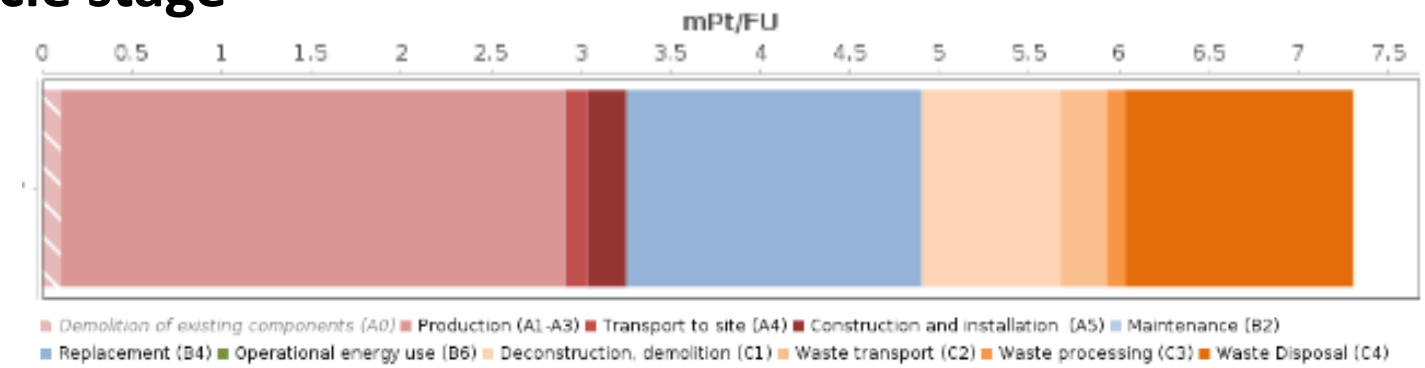
Materials [mPt/FU]	Energy [mPt/FU]	Total [mPt/FU]
7.3	0	7.3

III. TOTEM TOOL

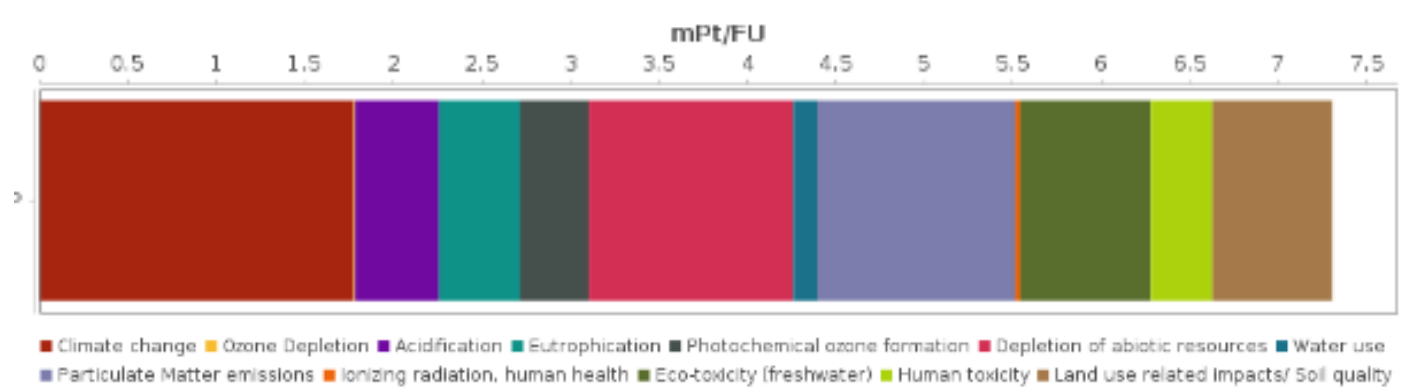
- Results: element scale

Example: storey floor

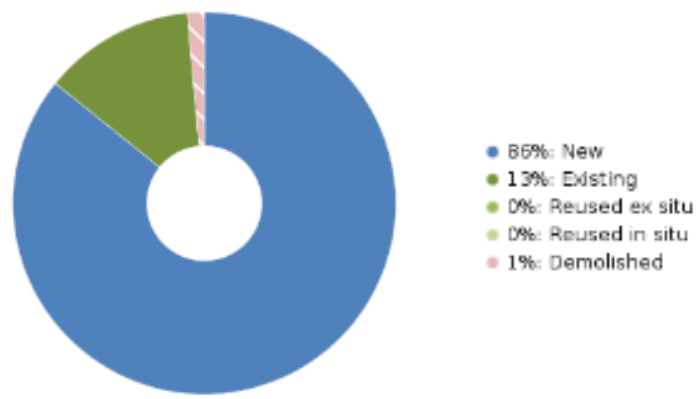
Impact per **life cycle stage**



Impact per **environmental indicator**



Impact per **status**

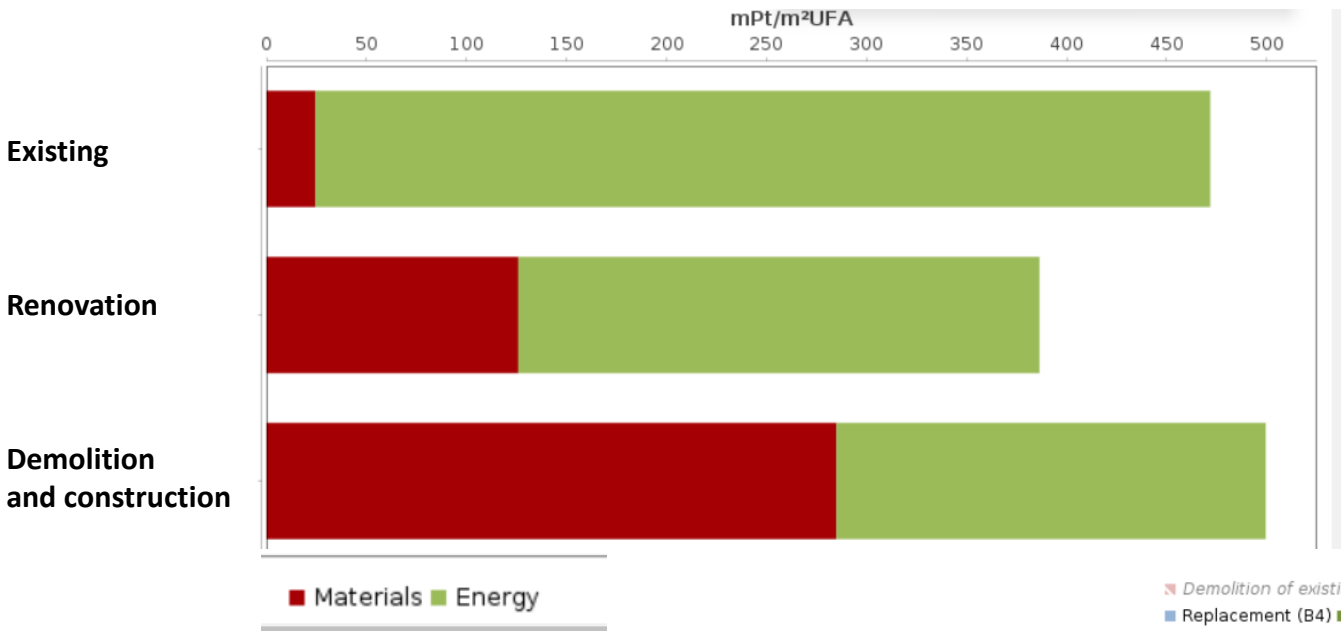


III. TOTEM TOOL

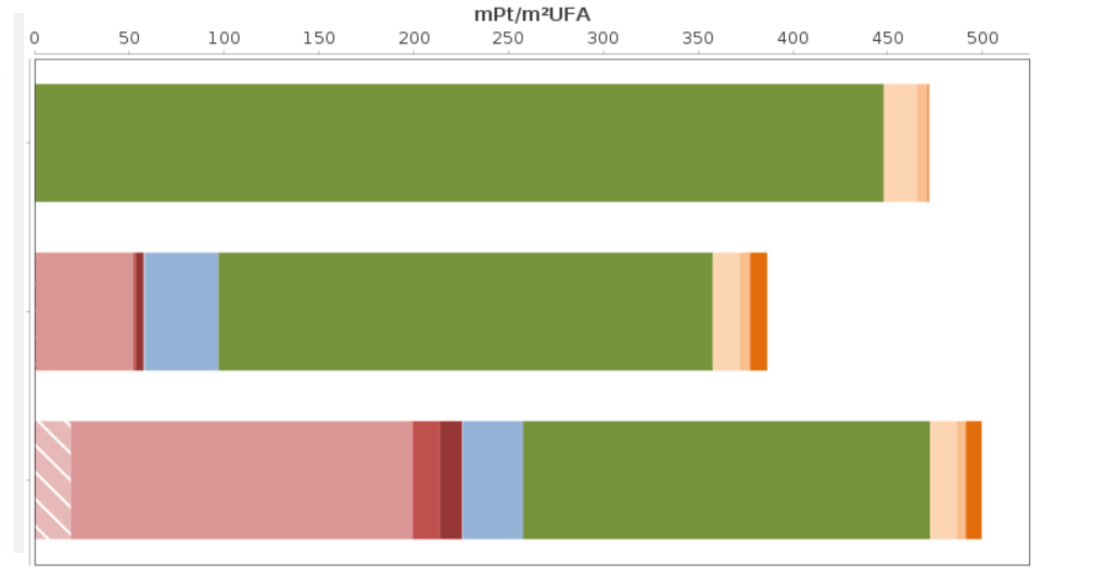
- Results: building scale

Scenario comparison

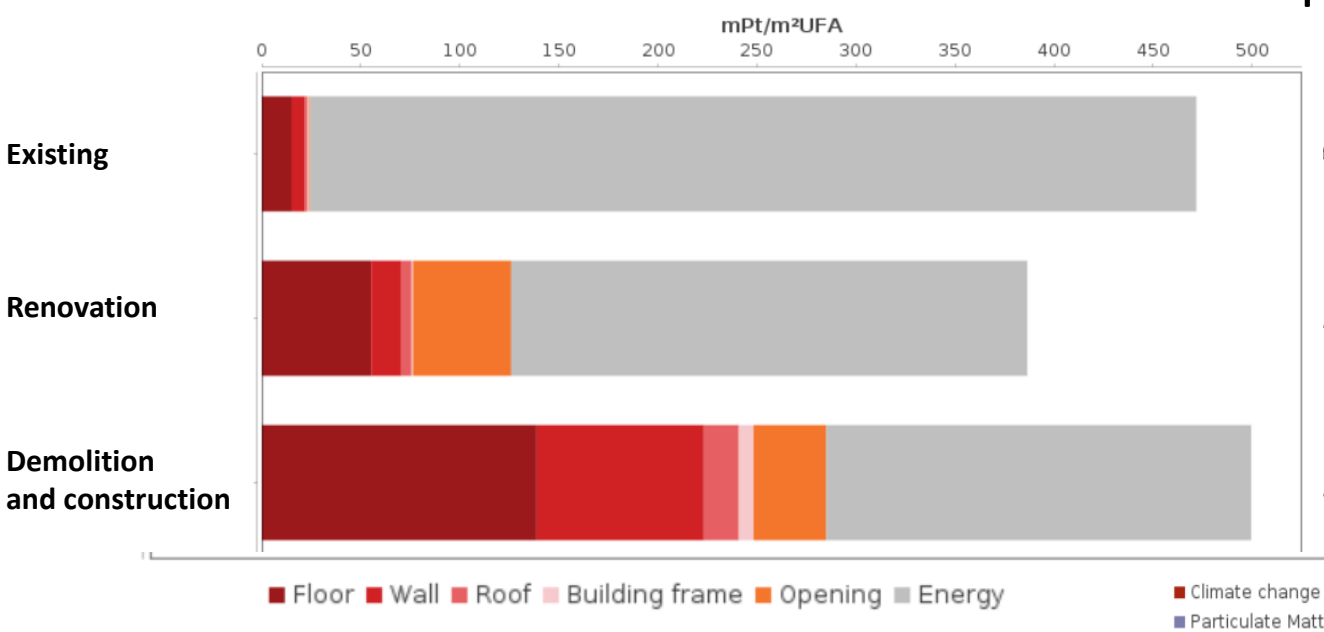
Materials vs. **energy** impact



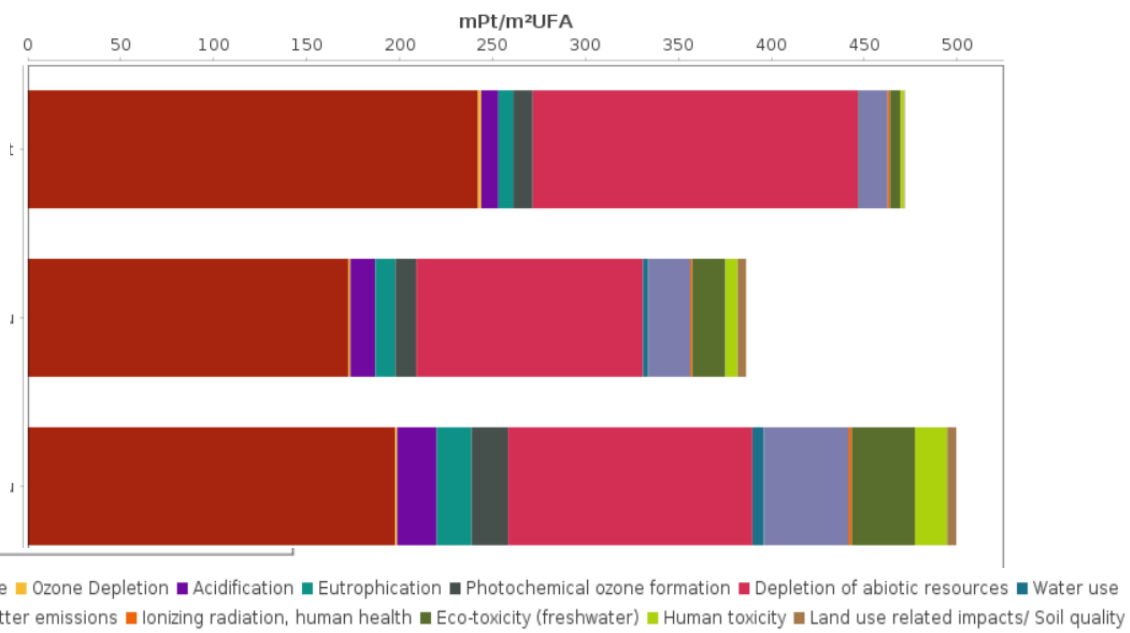
Impact per **life cycle stage**



Impact per **element category**



Impact per **environmental indicator**



IV. CONCLUSION & OUTLOOK

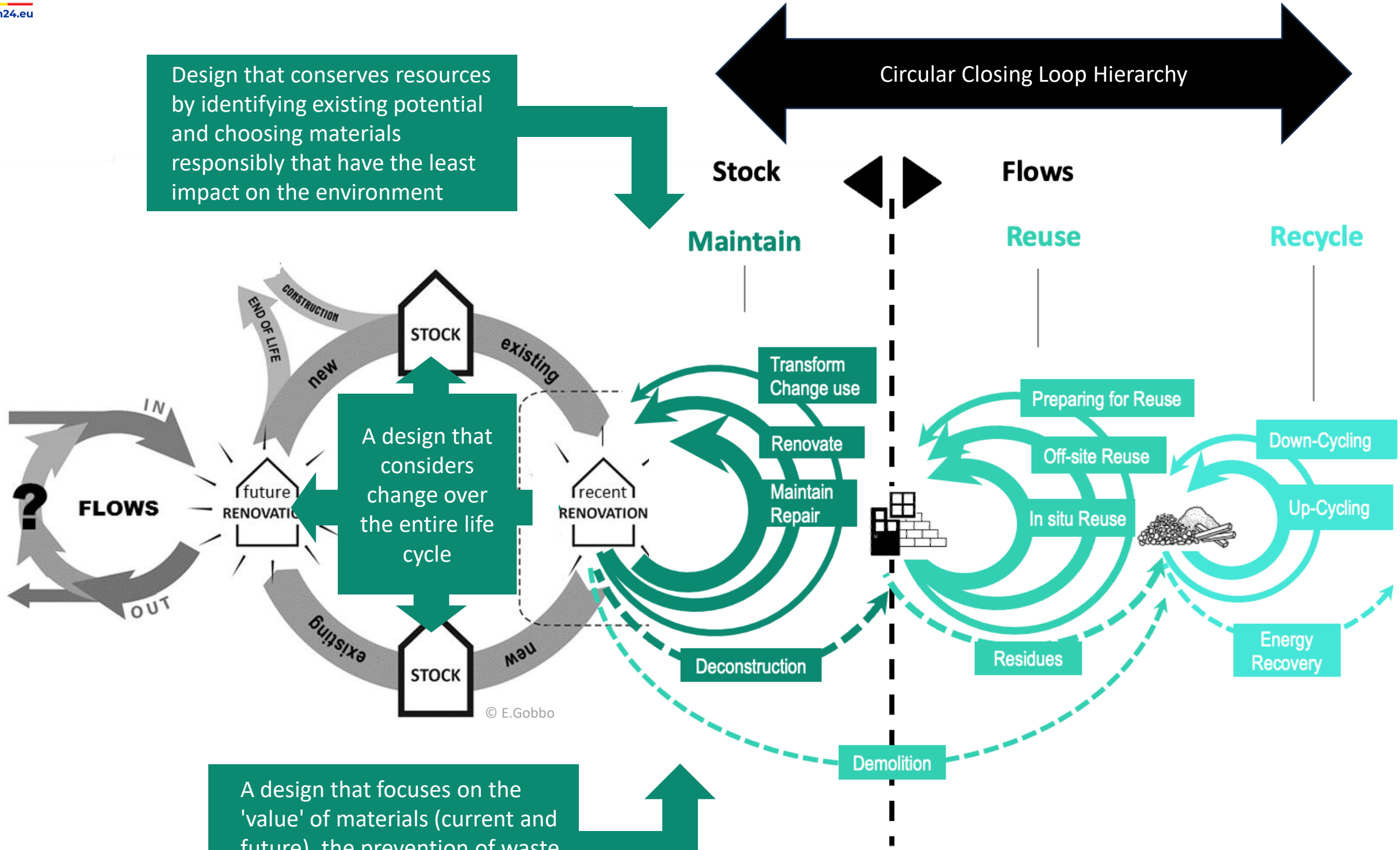
- Environmental issues must be considered from a **global, life-cycle perspective** (complex system: multiple indicators and scale of actions interconnected)
- **Several tools available** (different stages/scales) but it's not easy use/interpret them properly >> **awareness-raising** and **training** needed
- **TOTEM**
  - **Free tool** / common for the 3 Regions (Open Access)
  - Aligned with the 2 main EU standards related to LCA (EN 15804+A2 :2019 & 15978 :2011) > making it possible to compare results with other EU tools
  - Scenarios based comparison > to make well-considered, well-argued decisions
  - **Voluntary approach** > Development of a favorable "incentive" framework
  - **No thresholds** currently defined but work in progress through the GRO Tool
    - GRO: definition of thresholds in progress for non-residential:

    excellent < 70 mPts/m², better < 80 mPts/m² and good < 90 mPts/m²
  - **Evolving tool**: improvements are made regularly, based on changes in the regulatory framework and feedback from users
    - Current revision of the EPB directive:
      - LCA integration
      - Progressive implementation (in stages, starting with new buildings): Horizon 2028 = 1st stage
      - Thresholds expected by 2030

IV. CONCLUSION & OUTLOOK

Design that conserves resources by identifying existing potential and choosing materials responsibly that have the least impact on the environment

Circular Closing Loop Hierarchy



A design that focuses on the 'value' of materials (current and future), the prevention of waste and its reduction through improved recovery

TOOLS, WEBSITES, BIBLIOGRAPHY

https://www.totem-building.be/

https://www.gro-tool.be/?lang=fr

https://www.guidebatimentdurable.brussels

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https://www.fsc.be/fr-be

https://www.pefc.be/fr

https://www.nordic-ecolabel.org/

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