#5: I A Roadmap to circular renovation solutions: Integrating urban mining and reuse strategies in the design and construction of facade renovation system

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AEGIR

Kanton Bern
Canton de Berne

ADVANCED BUILDING SKINS

Resource transition through Renovation

- Conserving resources through renovation
- 85% of the European building stock was built before 2001 and does not comply with energy standards
- Deep renovation saves over 60% of energy demand

Picture:
The U.S. National Archives.

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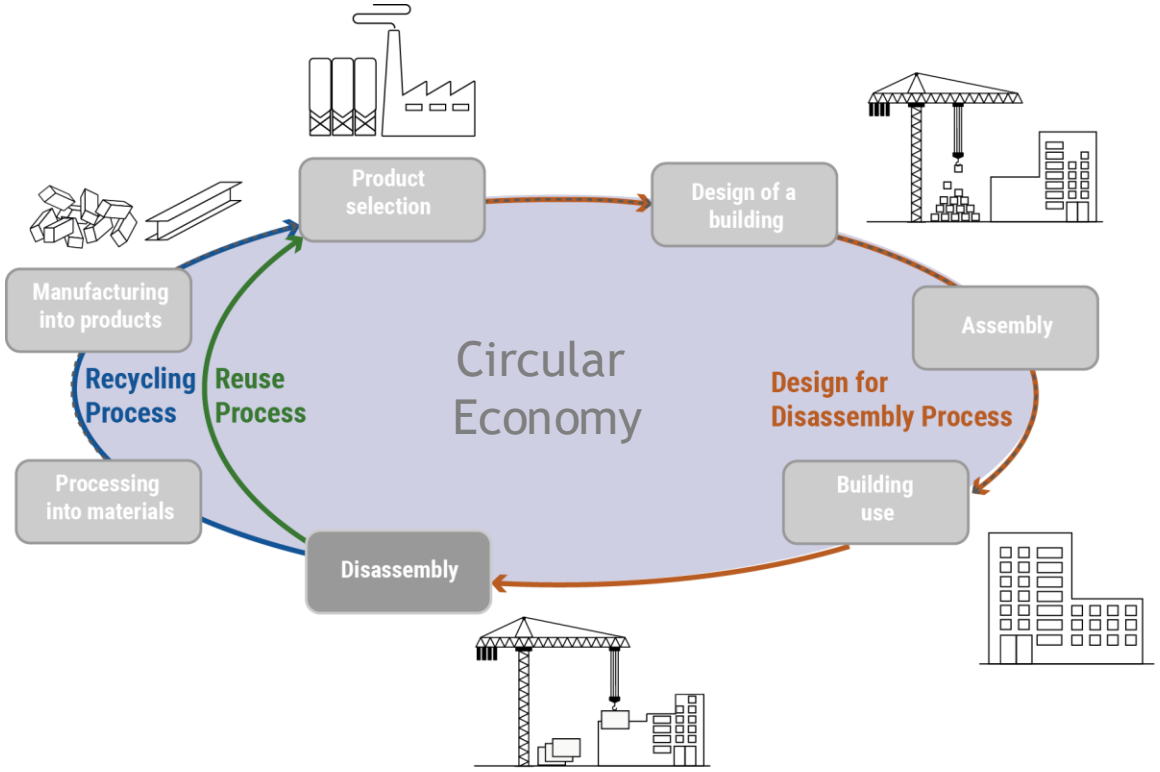
‘Circular economy’ is an industrial model restorative by intention

- **Rethinking** the entire value chain of buildings, components and materials.
- **Reuse, Recycling** and **Design for disassembly** reduces resource consumption and waste production.
- **Renovation** of buildings is central to follow Reduce, Reuse, Recycle (3R) strategies.



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AEGIR's approach for Circular economy

- **Measure circularity**
- Apply **Circular Economy strategies** and **broader sustainable** principles **on different levels**
- Create a business plan
- Raising awareness on existing **standards.**

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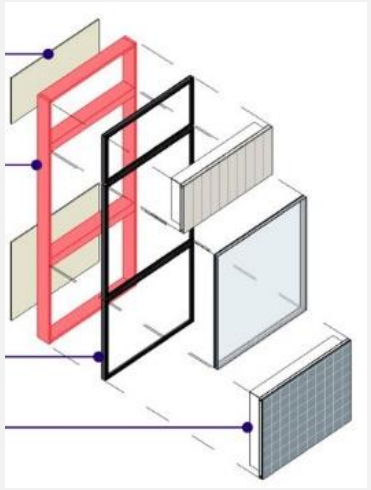
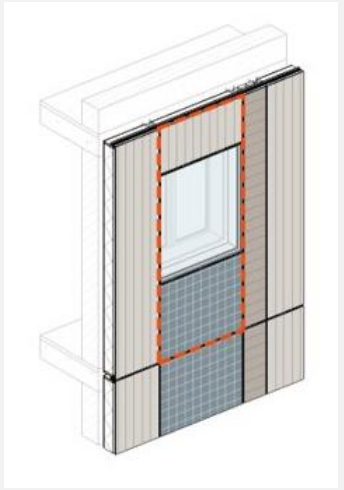
AEGIR's approach

	Component	Assembly	Building
• **Measure circularity**			
• Apply **Circular Economy strategies** and **broader sustainable** principles **on different levels**			
• Create a business plan			
• Raising awareness on existing **standards.**			

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Key Performance Indicators

Based on Life Cycle Assessment (LCA)

Global Warming Potential

Renewable resources

Recycled material

Materials for reuse/recycling

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Key Performance Indicators

Based on Level(s) framework

Reused material

Durability

Bill of material

Demountability

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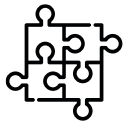
Key Performance Indicators

Based on

- Cradle to Cradle [1] and
- R-Strategies [2]

Material purity


Compostability


Modularity


Local material


Low-tech material


Financial concept

1: Braungart et al. (2002
2: Potting et al. (2017)

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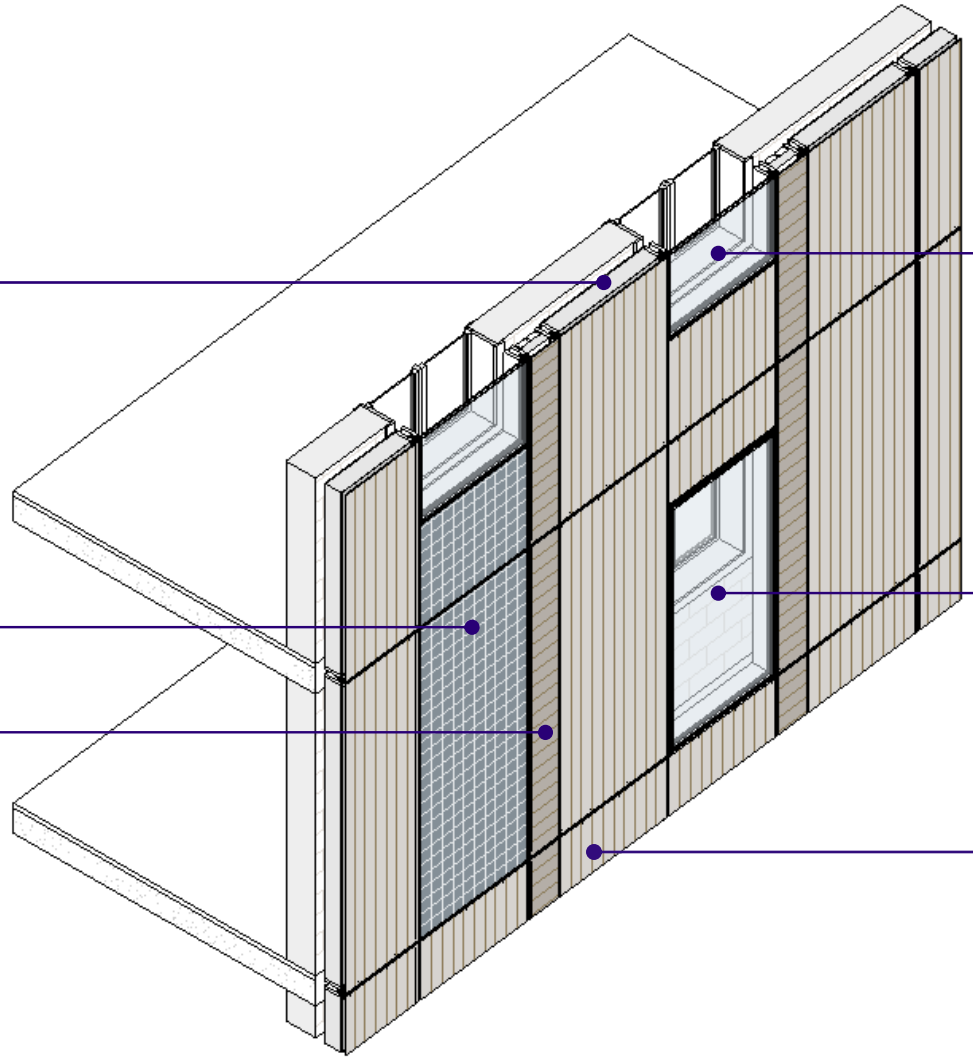
Key Performance Indicators



Recycled material

Insulation

Global Warming Potential

Modularity

PV panels

Healthy material

Ventilation

Demountability

Windows

Demountability

Windows

Durability

Cladding

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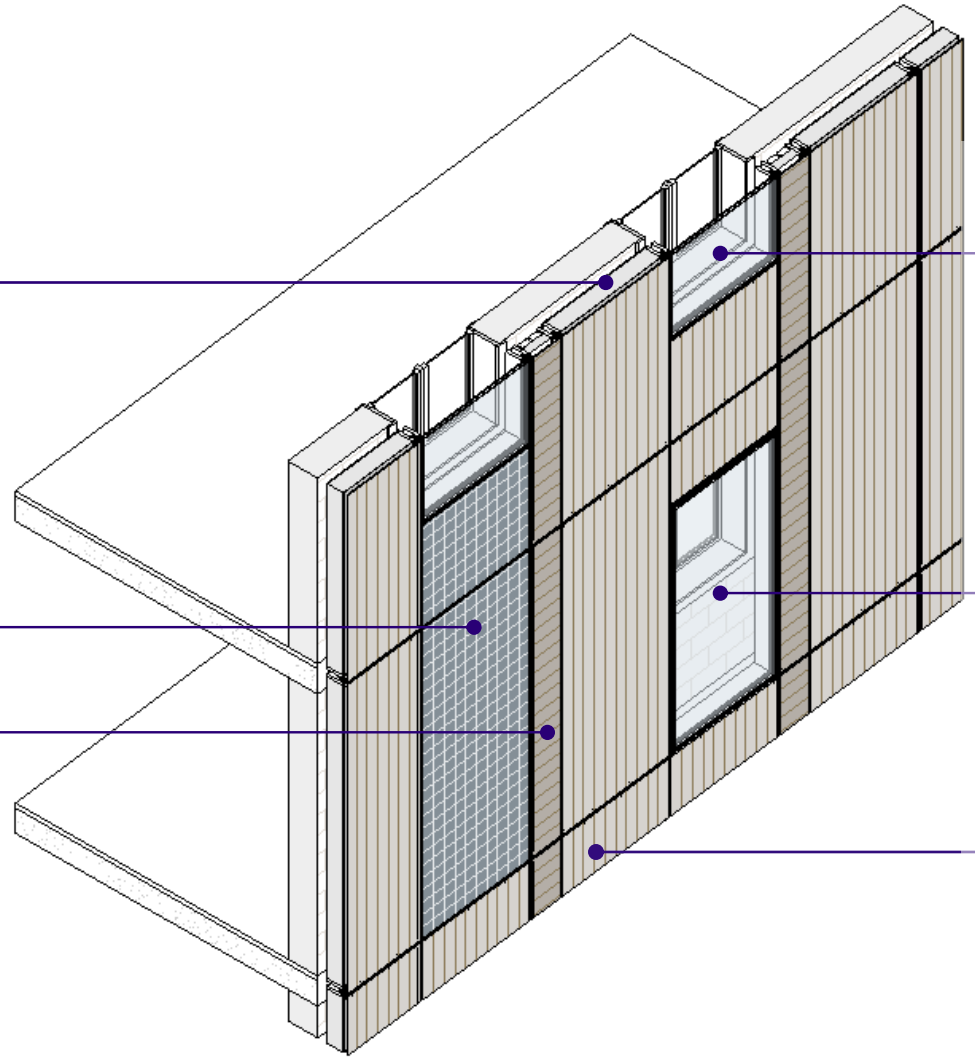
Key Performance Indicators

Insulation

Recycled material

Global Warming Potential



Windows

Demountability

Windows

Durability

Modularity

PV panels

Ventilation

Healthy material

Demountability

Cladding

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How circular is this product?

- How high is the **carbon footprint**?
- How high is the **recycled/reused material** content?
- **How much carbon is stored in each material?**

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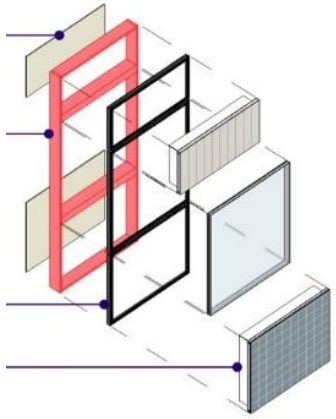
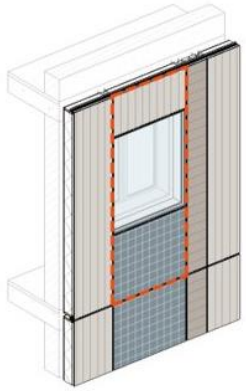
Assessment methods





- directly (x) and
- indirectly (/)

related frameworks

Instrument	Component	Assembly	Building
Life Cycle Assessment (LCA)	X	X	X
Environmental Product Declaration (EPD)	X	/	/
Level(s) Framework	/	/	X
Material Flow Analysis (MFA)	X	X	X

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Assessment methods

- directly (x) and
- indirectly (/)

related frameworks

Instrument	Carbon footprint	Recycled content	Carbon content
Life Cycle Assessment (LCA)	X	X	/
Environmental Product Declaration (EPD)	X	X	
Level(s) Framework	X	X	
Material Flow Analysis (MFA)		X	/

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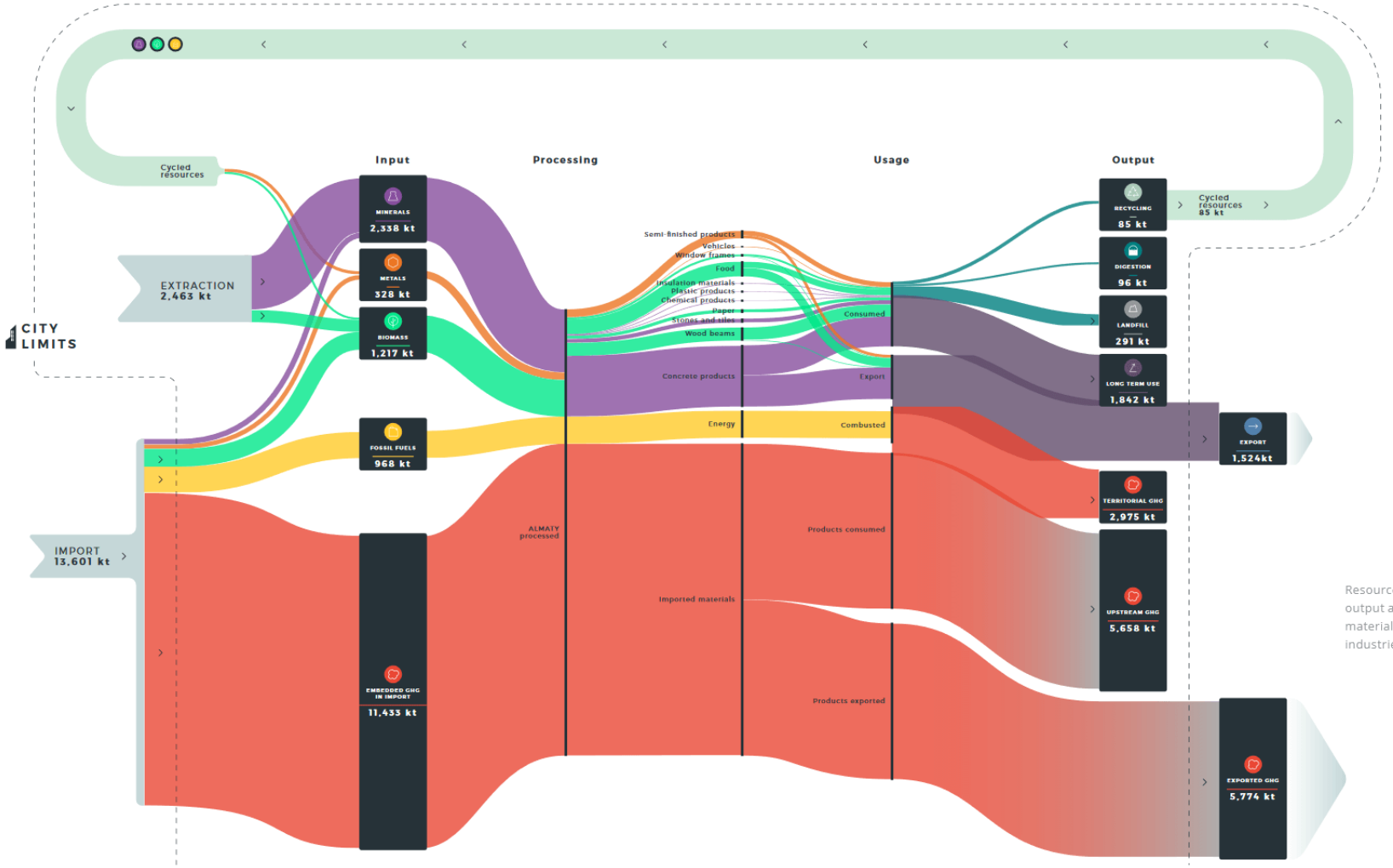
Material Flow Analysis

- Sankey diagram for mapping material streams
- Mass as an indicator



Source: www.shiftingparadigms.nl/projects/almaty/

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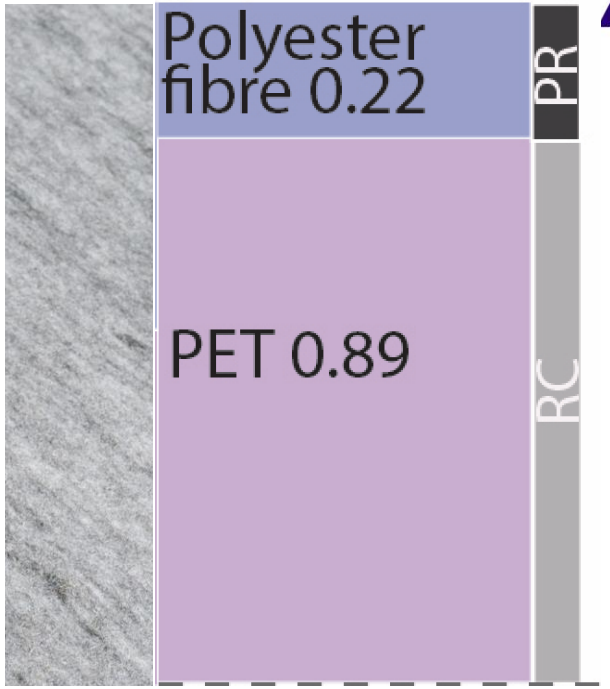
Carbon Flow Analysis (CFA)

Mixed approach combing:

- Material Flow Analysis
  - Recycled content [1]



1.11kg/m²

Insulation made of PET

1: EPD's

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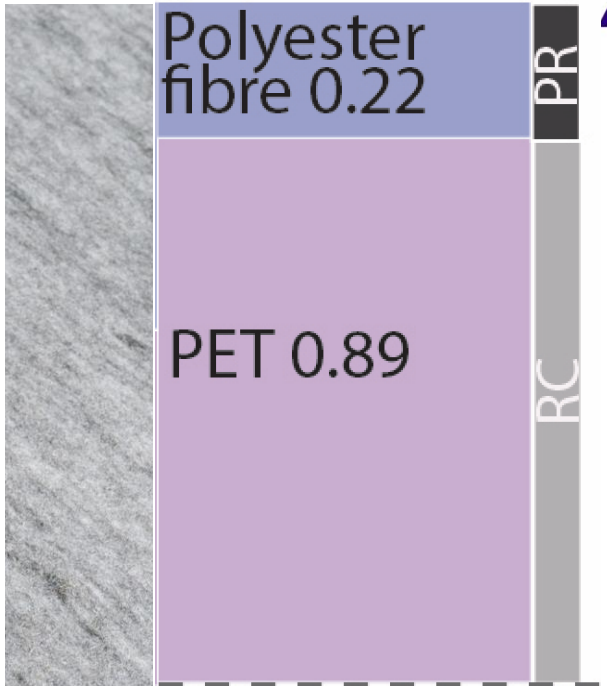
Carbon Flow Analysis

Mixed approach combing:

- Material Flow Analysis (MFA)
  - Recycled content[1]
- Life Cycle Assessment (LCA)
  - Total Global Warming Potential (GWP) [1]



1.77 GWP

1.11kg/m^2

Insulation made of PET

1: EPD‘s

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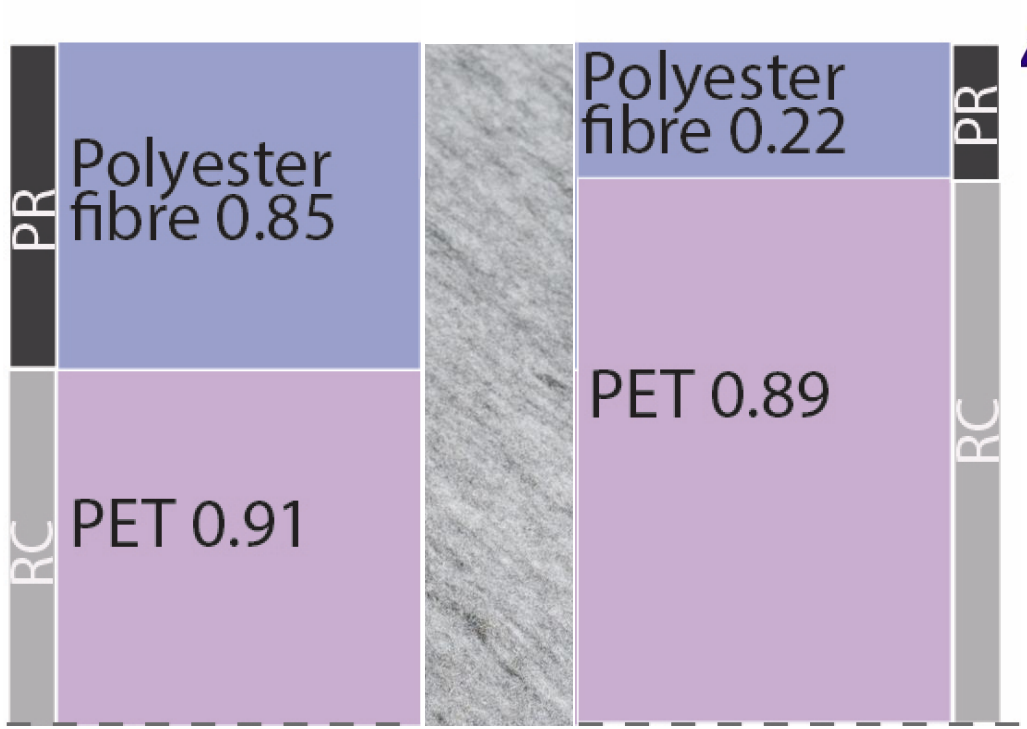
Carbon Flow Analysis

Mixed approach combing:

- Material Flow Analysis (MFA)
  - Recycled content[1]
- Life Cycle Assessment (LCA)
  - Total Global Warming Potential (GWP) [1]
  - Carbon content[2]



1.77 GWP

1.11kg/m^2

Insulation made of PET

1: EPD's
2: LCA platforms (ecoinvent, oekobaudat…)

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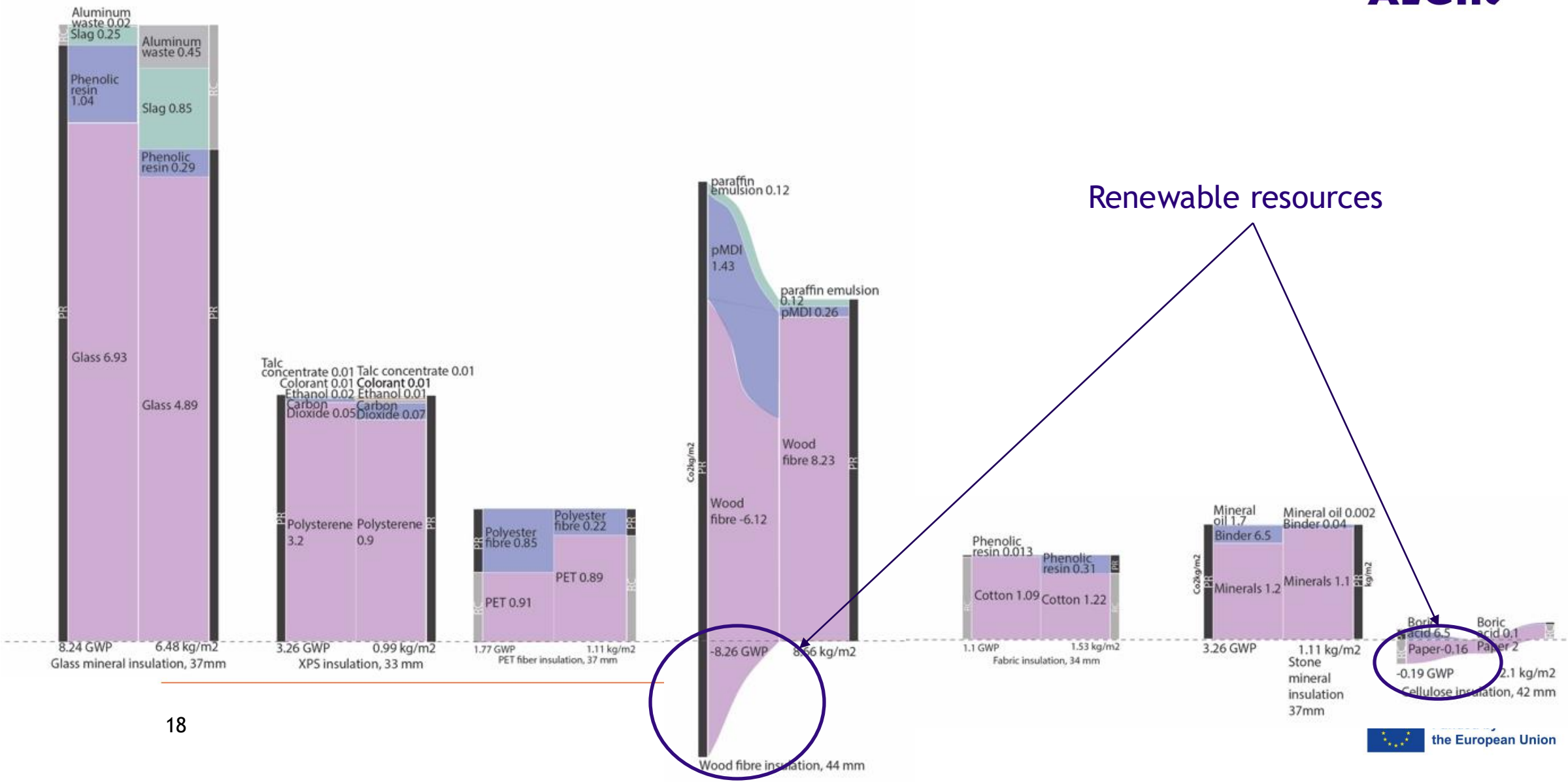
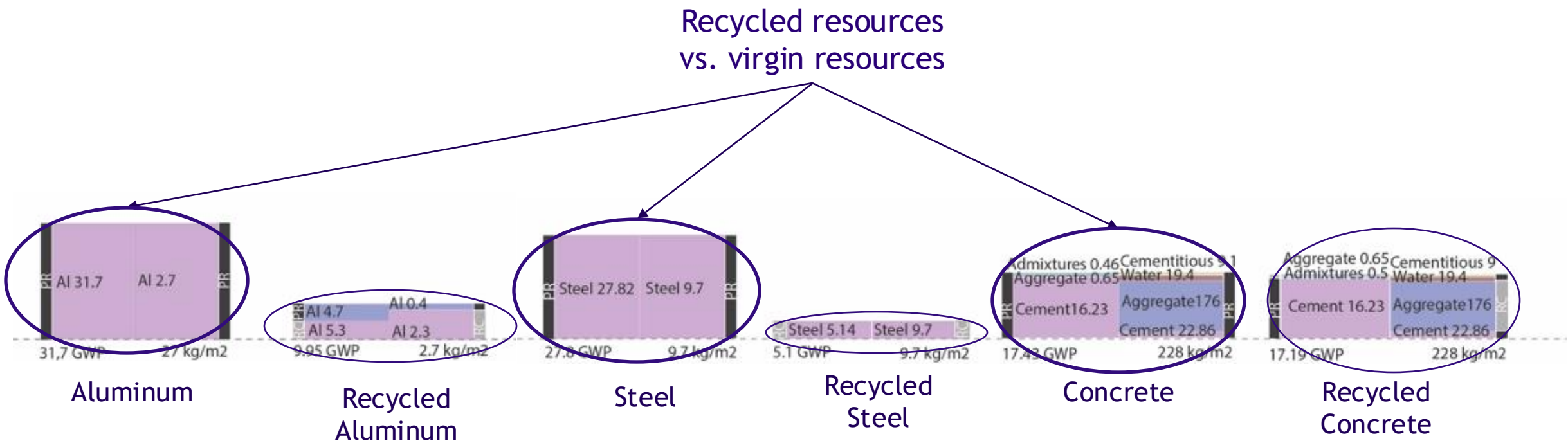
Carbon Flow Analysis - Insulation



Carbon Flow Analysis - Cladding



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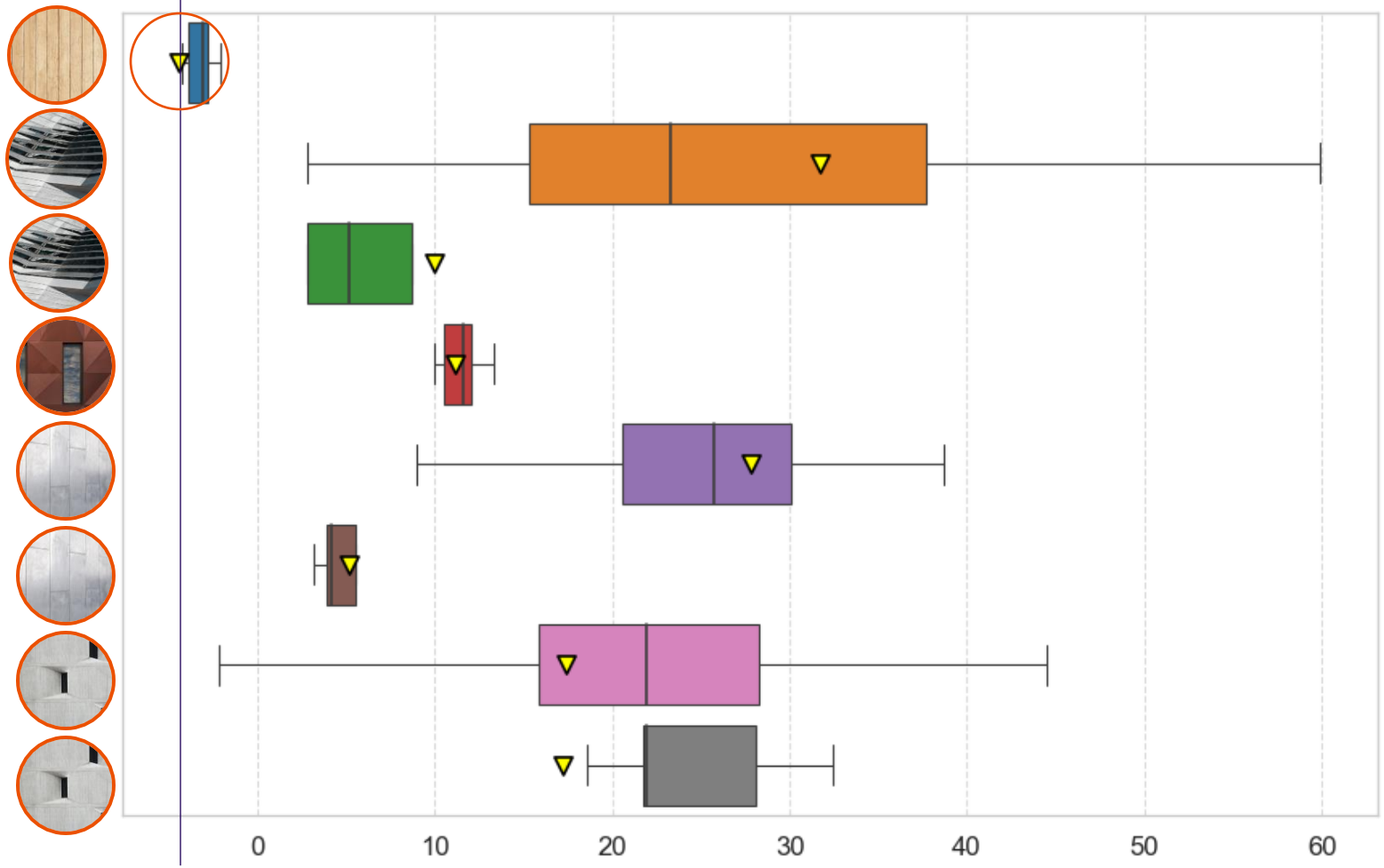
Contextualization of carbon footprint



Data sources

- Selected component: EPD
- 600 Data points: LCA platforms (ecoinvent, oekobaudat…)

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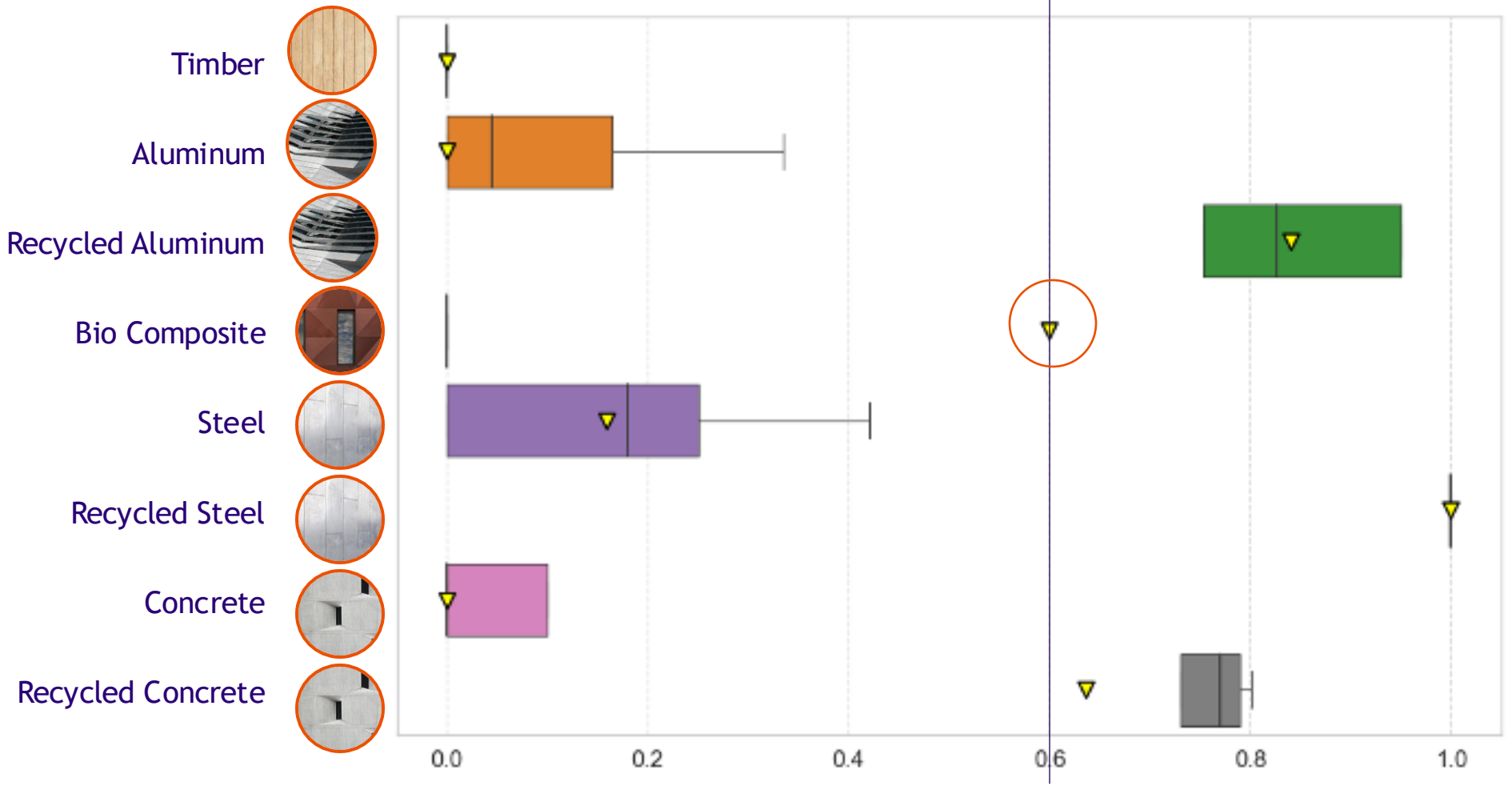
Contextualization of recycled content



Data sources

- Selected component: EPD
- Data points: LCA platforms (ecoinvent, oekobaudat…)

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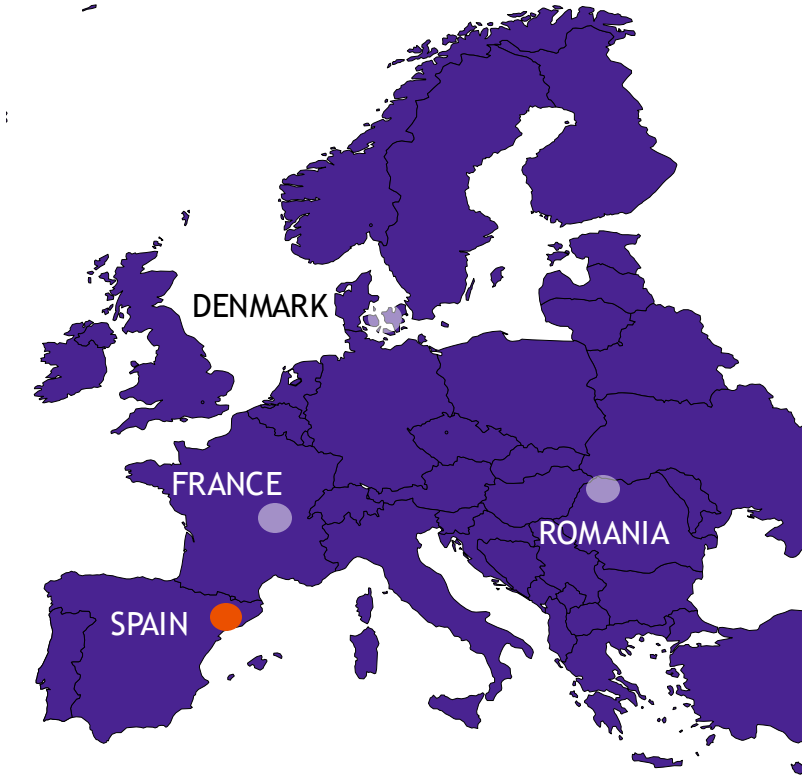
Spanish Demo

Educational building



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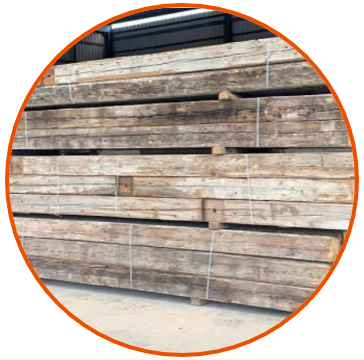
Reused wood

~0 % CO_2 EMISSIONS

100 % REUSED CONTENT

Construction timber



Pallets

Eucalyptus Mussle platforms

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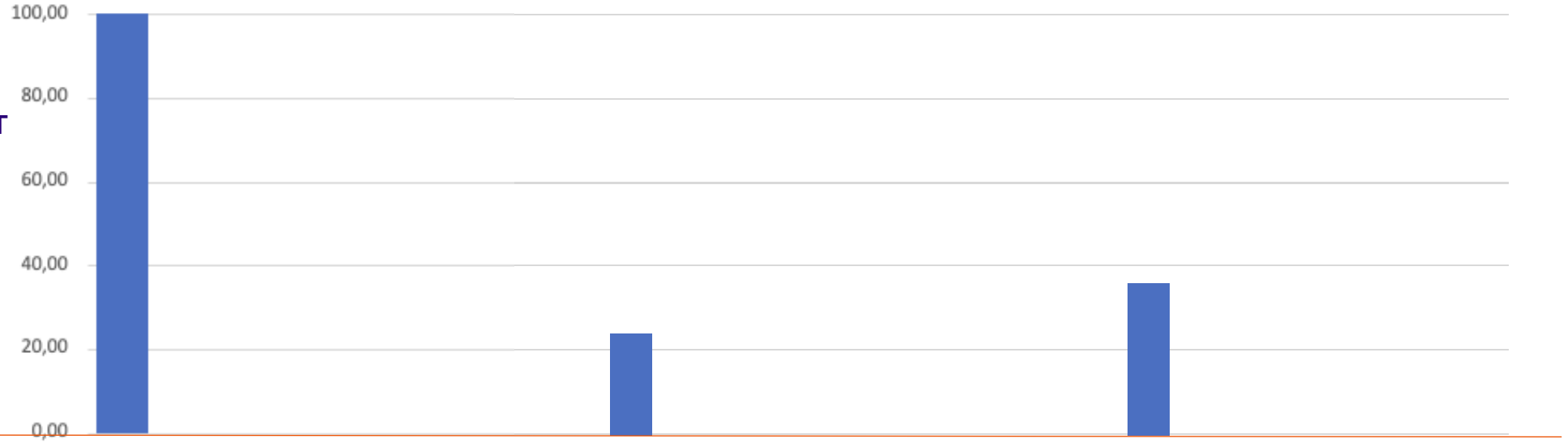
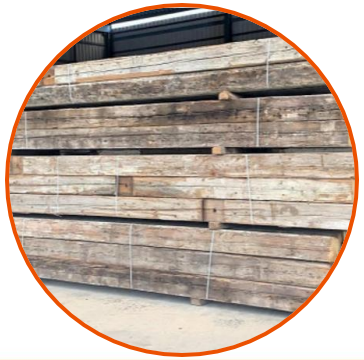
Reused wood

~0 % CO_2 EMISSIONS

100 % REUSED CONTENT



Construction timber



Pallets

Eucalyptus Mussle platforms

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Spanish Demo

mussle platforms

Cladding

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Life Spans

1st Life (~25 y.)

2nd Life (~30-50 y.)

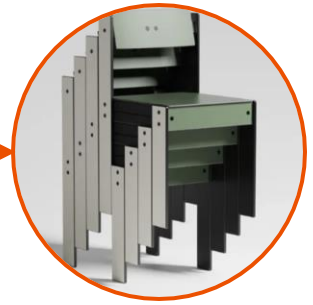
1st Life (~30-50 y.)

Bio Composite

3rd Life

Up to 27% of wood can be reused[1]

2nd Life (~10 y.)



Chairs

1: PICCARDO C., HUGHES M. (2022) Design strategies to increase the reuse of wood materials in buildings, Journal of Cleaner Production

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Conclusions – Measure circularity

- Deeper analysis of components on material level with CFA (LCA only shows total GWP)
- Manufacturers can improve their components based on carbon flows instead of material flows
- Analysis of qualitative KPI‘s is missing (e.g. demountability)
- Generic way to measure carbon flows, each project needs an individual approach
- Changing a product according to CE principles is a longterm goal (~7 y.)

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Conclusion- Apply Circularity principles

Reuse of wood

- Prices similar or event cheaper than virgin material
- Future reuse can be improved e.g. through construction method or take back systems
- Transportation distance is not ideal

Down sides

- Further treatment due to hazardous substance/performance/aesthetics
- 100 % incineration in future material path[2]
- Need maintenance to reach long lifespans

2: CRISTESCU C. et al. (2020) Design for deconstruction and reuse of timber structures

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Main Take-Aways

- Decisions need to be aligned with Circularity KPI‘s throughout the process
- Support decision makers with **FACTS** (carbon footprint, recycled content, future recycling paths)

Challenges

- Difficulties in gaining data (missing EPD, unknown material stream) > generic data
- LCA results can be misleading
- Entire value chains need to be changed so reuse becomes mainstream

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Incremental Renovation Package

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