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CBCI

Integrated Decision Support for Circular, Industrialised & Bio-based Construction Works

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Introduction

The Circular and Bio-based Construction Industry(CBCI) Interreg Project aims to standardize processes for achieving circular development in the construction sector. The outcomes of research are displayed in real-life settings via creation of living labs (LL).

This study investigates an integrated approach for supporting decision-making during design phase. Goals of the study are:

- Integration of circularity tools into current assessment tools
- Providing support for the design of LL Ghent

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Decision Support

It was observed current life cycle assessment practices provide solid outcomes for environmental impact, but there is a need for integration with circularity tools for estimation of end-of-life (EoL) scenarios.

This study investigates the relationship between tools as seen below:

- Circularity
  - Reuse and recycling – BBRI Tool
  - Material flows – CB'23 Platform
- Environmental impact
  - Life cycle assessment (LCA)

Decision Support - Methodology

BBRI evaluation on reuse and recycling

- Result:
  - New material flows in CB'23
  - New percentages for end-of-life scenarios

Model LCA processes with new end-of-life scenario percentages

- Result:
  - Better impact for most of the circular materials

Compare the new results with standart TOTEM LCA results

- Result:
  - Estimate variation from standard LCA process

Circularity – BBRI Tool

The Flemish Construction Confederation and BBRI introduce a tool to help developers, architects, contractors in the construction sector to support decision-making with a circular perspective. Four sections are available:

- change-oriented design
- environmental impact
- urban mining
- transition towards a circular world

Circularity – BBRI Tool

For this study, 'Design for reuse and recycling' calculator is utilized, which is a part of the 'Change-orientated design' pillar. In the reuse and recycling calculator, the following properties are scored:

- avoided material impact
- functional independence
- technical detachability
- physical characteristics
- recyclability.

Circularity – CB’23

Platform CB'23 stimulates the transition to a circular and sustainable construction economy with a material quantification method. The method incorporates three aspects:

- preservation of material supplies
- environmental impacts and
- technical and economic value preservation

Integration with LCA

Inclusion of Module D in LCA for assessing benefits beyond lifetime is crucial for a circular building design.

- There are recommendations for assumed destinations for EoL in the existing LCA frameworks (TOTEM)
- There is a lack of methods on how to model EoL for a higher precision, and specifically for circular buildings.

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Case Study - LL Ghent

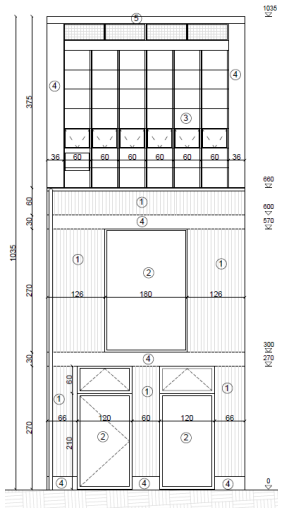
LL Ghent follows the principles below in order to reach the above mentioned goals:

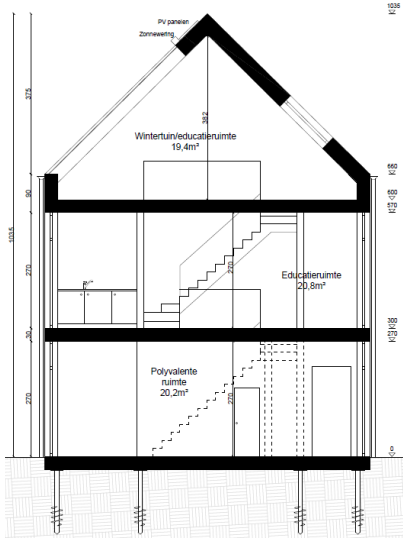
- Sustainability
- Circularity
- Bio-based materials use
- Industrial materials and methods
- Involvement of social economy

Case Study - LL Ghent

The Living Lab is a single terraced building prototype to be industrialized in a flexible and affordable way for renewal projects in vulnerable urban neighbourhoods. Novelty of the construction is:

- After the first assembly as a prototype on the Technology Campus of the KU Leuven, it will be disassembled and reassembled in one of the renewal areas in Ghent after the Interreg-project.





Case Study - LL Ghent

Nine preliminary designs (PD) were drafted to compare different materials and construction methods.

- PD1: Masonry - Traditional
- PD2: Masonry - Optimized
- PD3: Steel – Post-beam
- PD4: Steel framing
- PD5: Wood framing
- PD6: Wood – Post-beam-Insulated panel (IP)
- PD7: Wood – Structural Insulated (straw) Panel (SIP)
- PD8: Wood – Cross Laminated Timber (CLT)
- PD9: Wood – Insulated bock system

Heavy-weight

Light-weight

Bio-based

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Case Study - LL Ghent

PDs & Comp	1 Front Façade	2 Side Façade	3 Internal Wall	4 Inclined Roof	5 Floor	6 Floor on Soil
1 – Masonry	Masonry wall brick finish	Masonry wall with slate finish	Brick and plaster and paint	I beam + mineral wool + roof tiles	Vaulted concrete with stone tiles	Concrete slab with stone tiles
2 – Masonry Optimized	Masonry wall with facade click finish	Masonry wall with slate finish	Gypsum board + bio-based paint	I beam + cellulose + roof tiles	Concrete with ceramic boxes + stone tiles	Glass granulate + wood finish
3 – Steel Post Beam	Steel structure Sandw. panel Aluminium cladding	Steel structure Sandwich panel	Gypsum board + bio-based paint	Steel structure Sandwich panel	Steel plate concrete Stone tiles	Concrete slab with stone tiles
4 – Steel Framing	Steel framing Aluminium cladding	Steel framing Stale finish	Gypsum board + bio-based paint	Steel framing PUR insulation Steel sheeting	Steel profile Stone tiles	Concrete slab with stone tiles
5 – Wood Framing	Wood framing brick finish	Wood framing slate finish	Gypsum board + bio-based paint	I beam + mineral wool + roof tiles	Trusses Wood finish	Concrete slab with stone tiles
6 – Wood Post Beam	Caisson + osb Ceramic finish	Caisson+osb Slate finish	Gypsum board + bio-based paint	Caisson+osb Mineral wool roof tiles	Trusses Caisson+osb Wood finish	Caisson+osb Wood finish
7 – Wood SIP Straw	Timber framing Straw bale	Timber framing Straw bale Slate finish	Gypsum board + bio-based paint	I beam + cellulose + roof tiles	Trusses Engineering wood floor	Sea shells Pearls Wood finish
8 – Wood CLT	CLT Wood fibre Wood finish	CLT Wood fibre Slate finish	Gypsum board + bio-based paint	CLT Wood fibre	Trusses CLT	Concrete slab Resol insulation
9 – Wood Modular Block	Modular blocks Wood fibre Wood finish	Modular blocks Wood fibre Slate finish	Gypsum board + bio-based paint	I beam + cellulose + roof tiles	Modular block Cork insulation	Concrete slab Resol insulation

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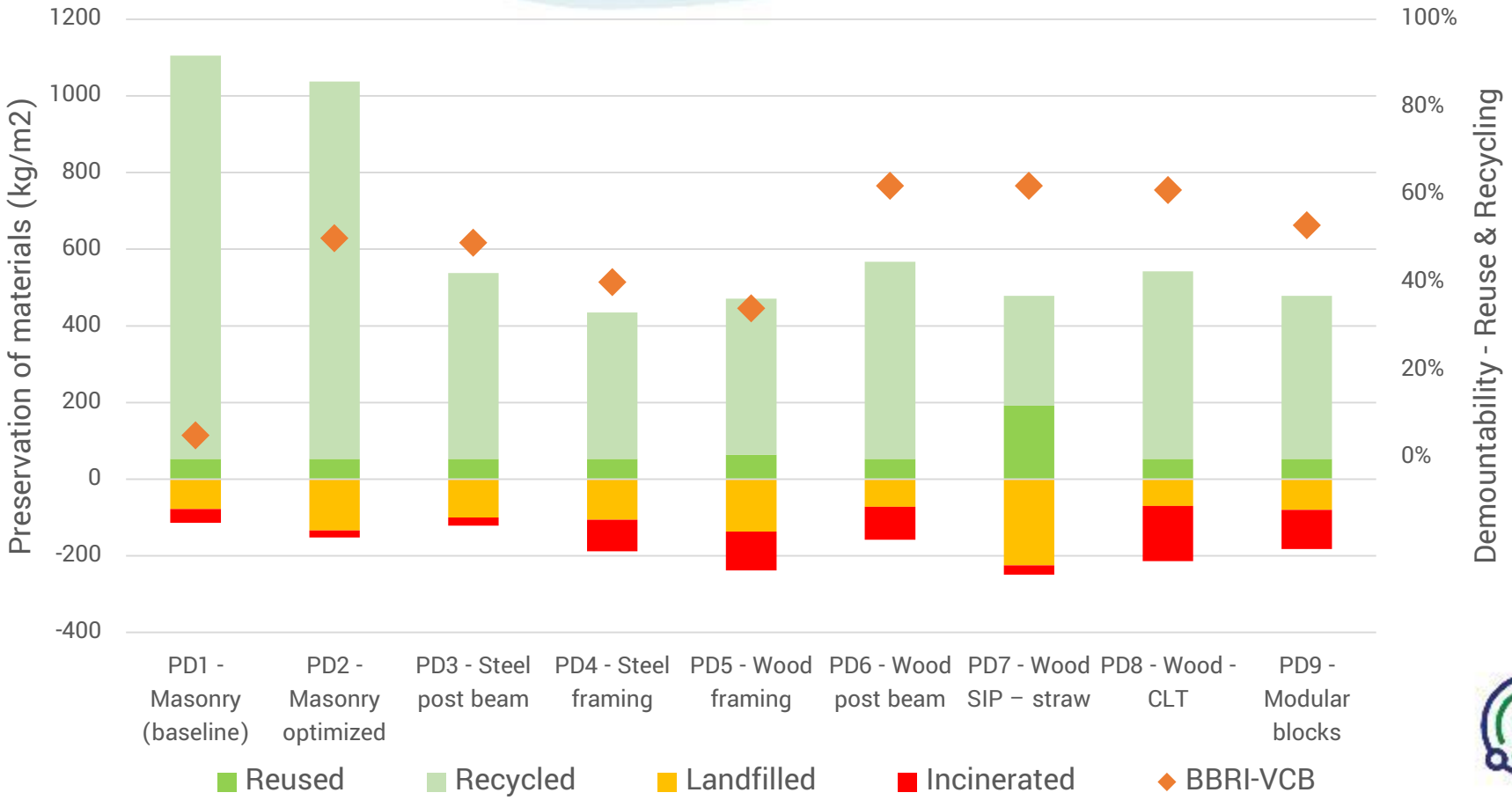
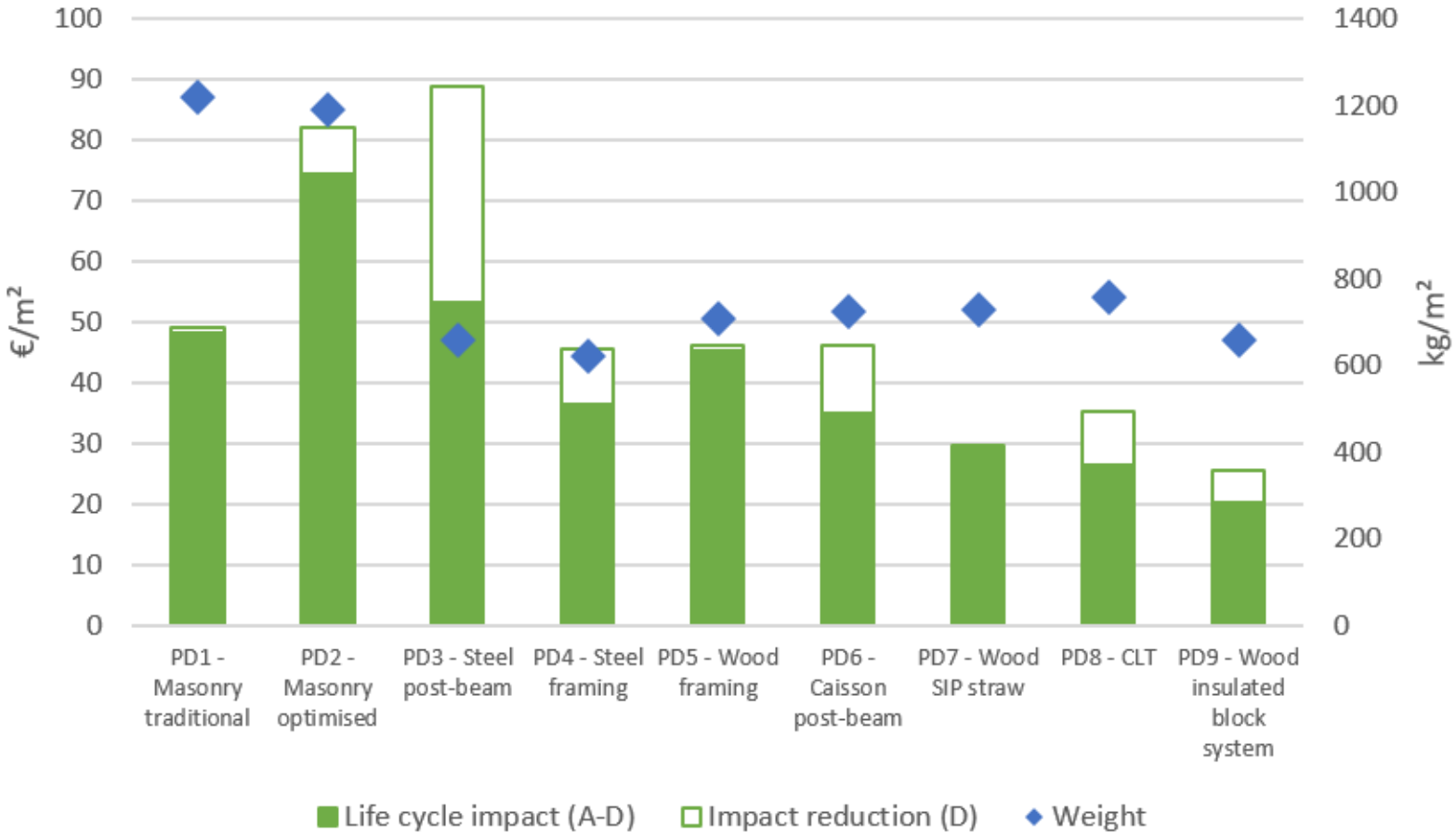
Results - Circularity



Results – Impact Assessment



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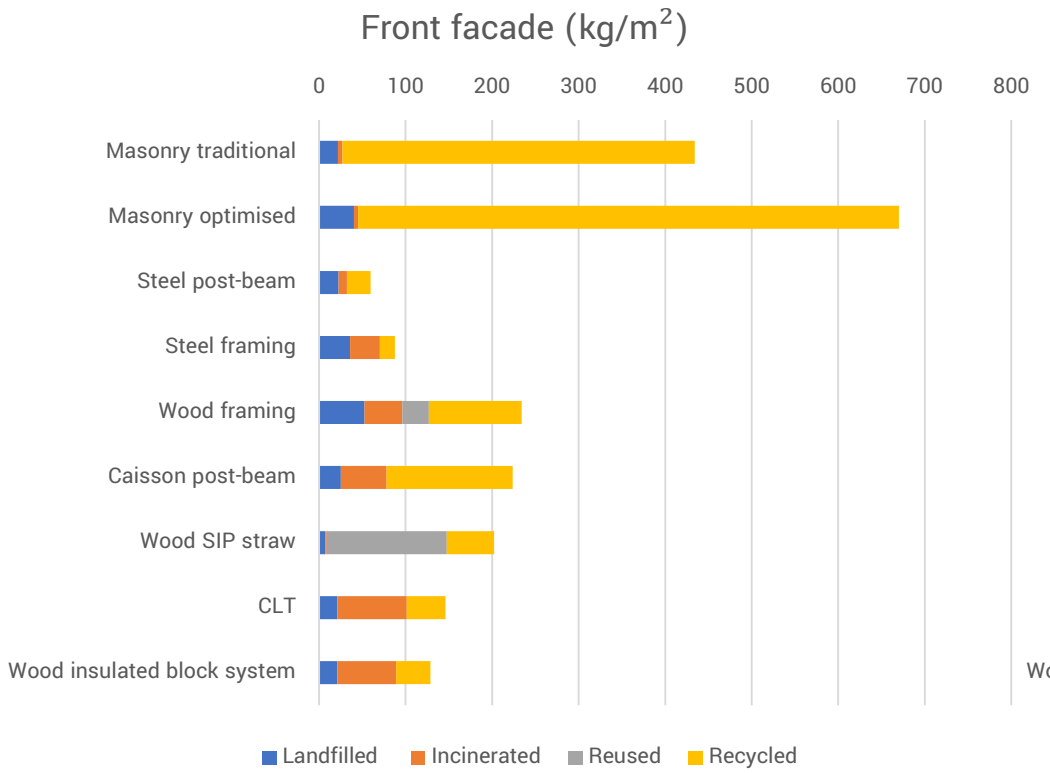
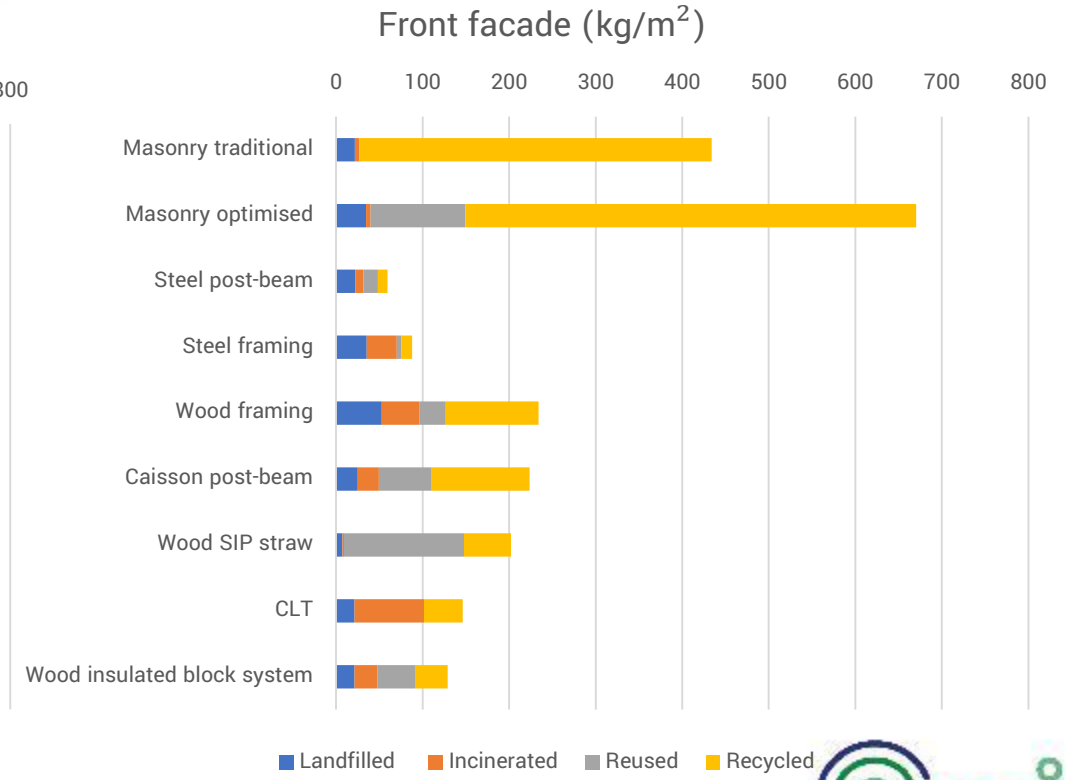
Results – Integration – CB’23 revised





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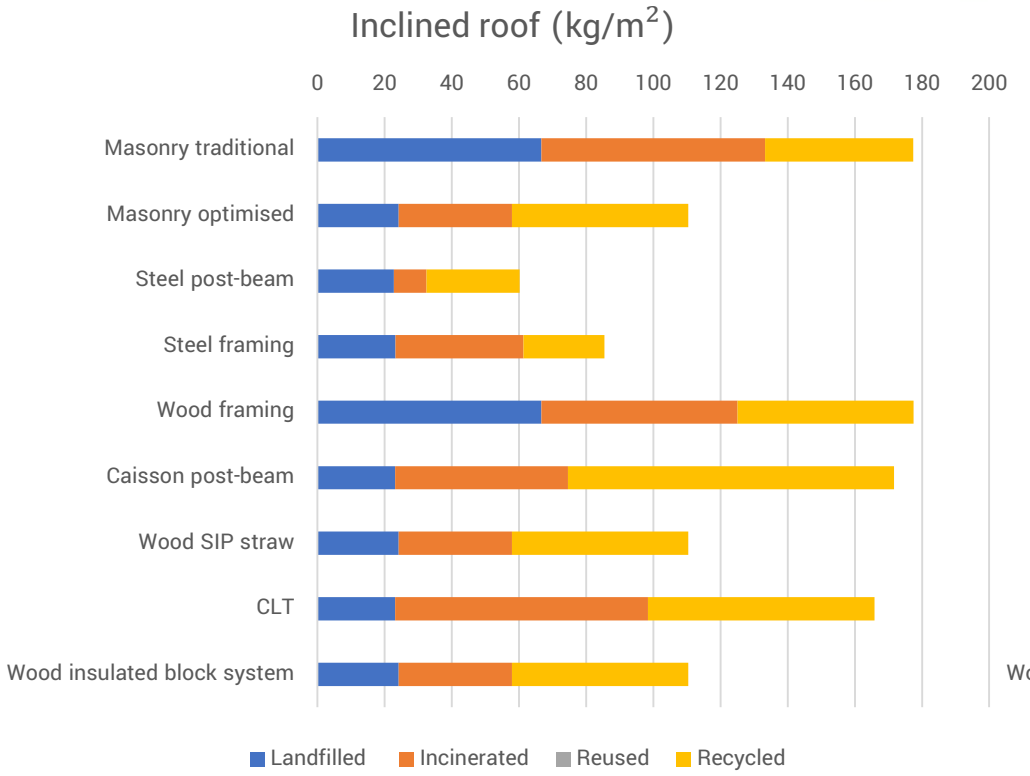
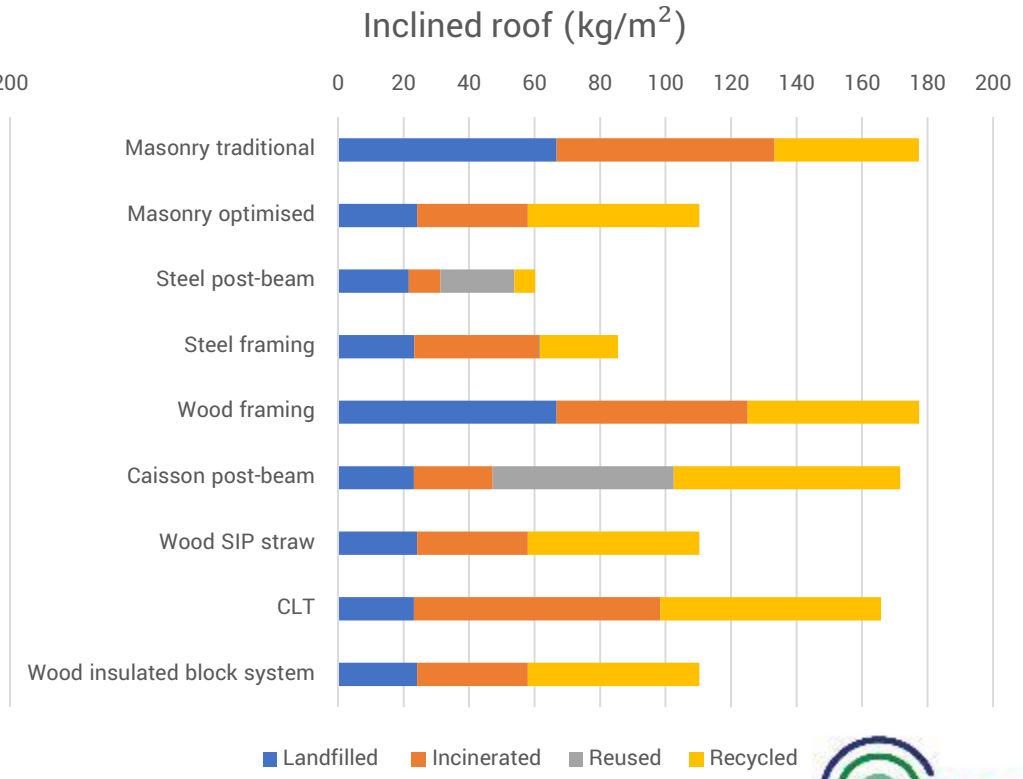
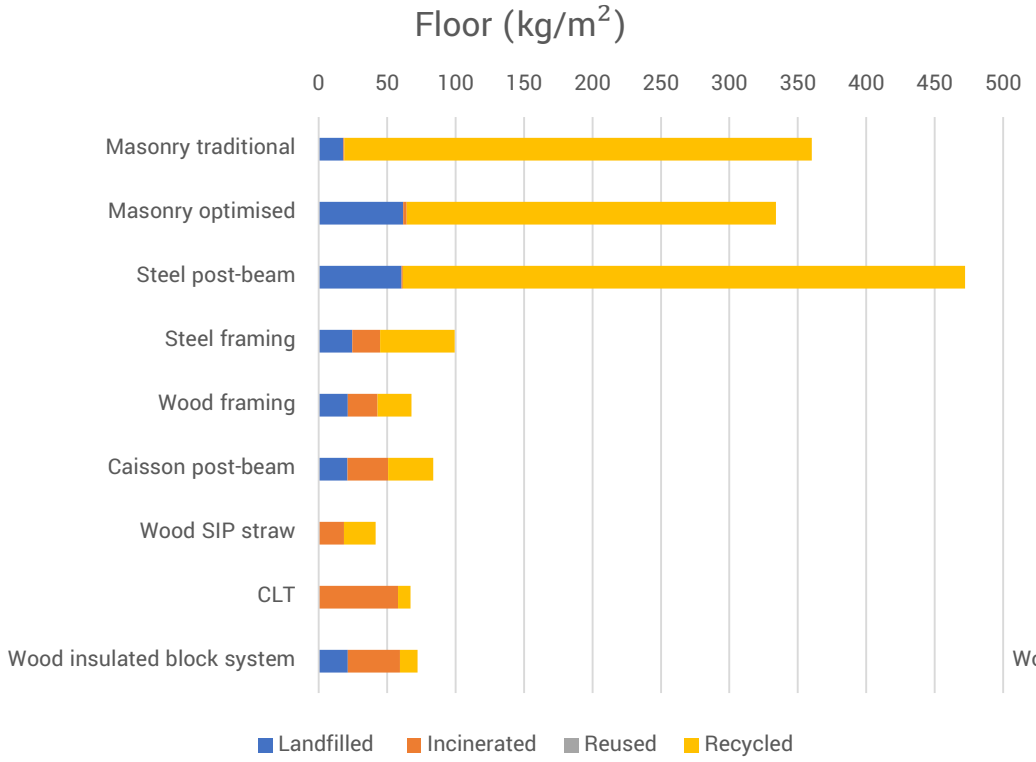
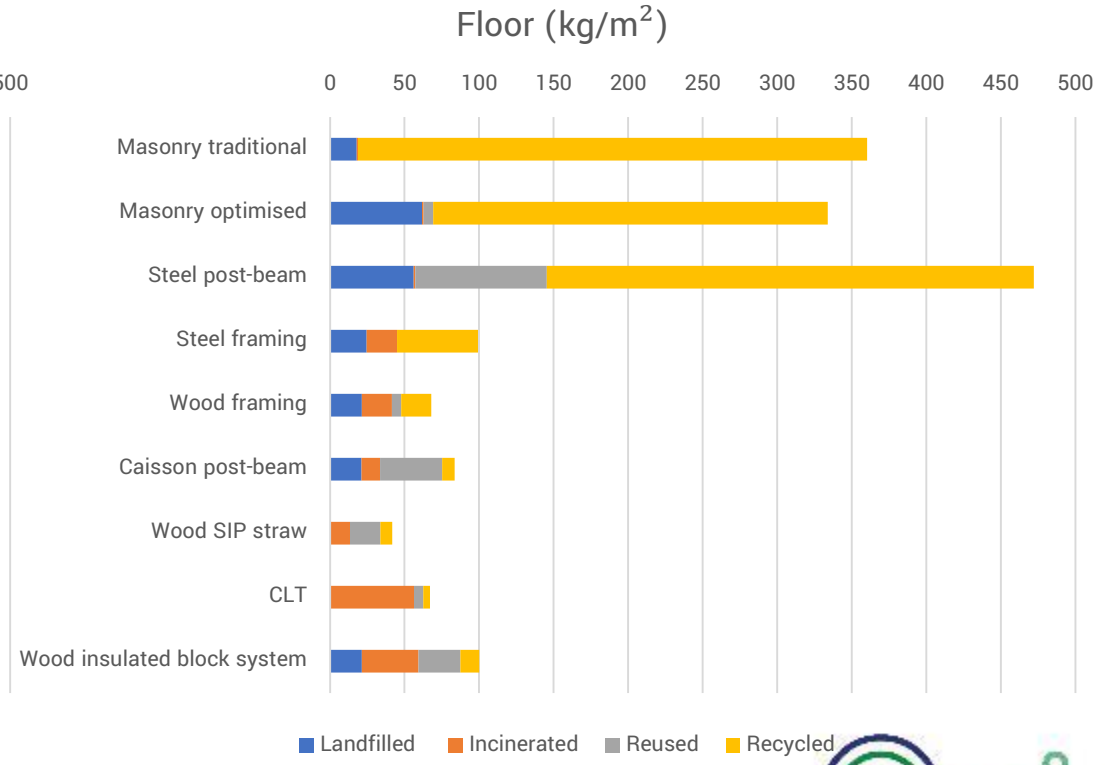
Results – Integration – CB’23 revised



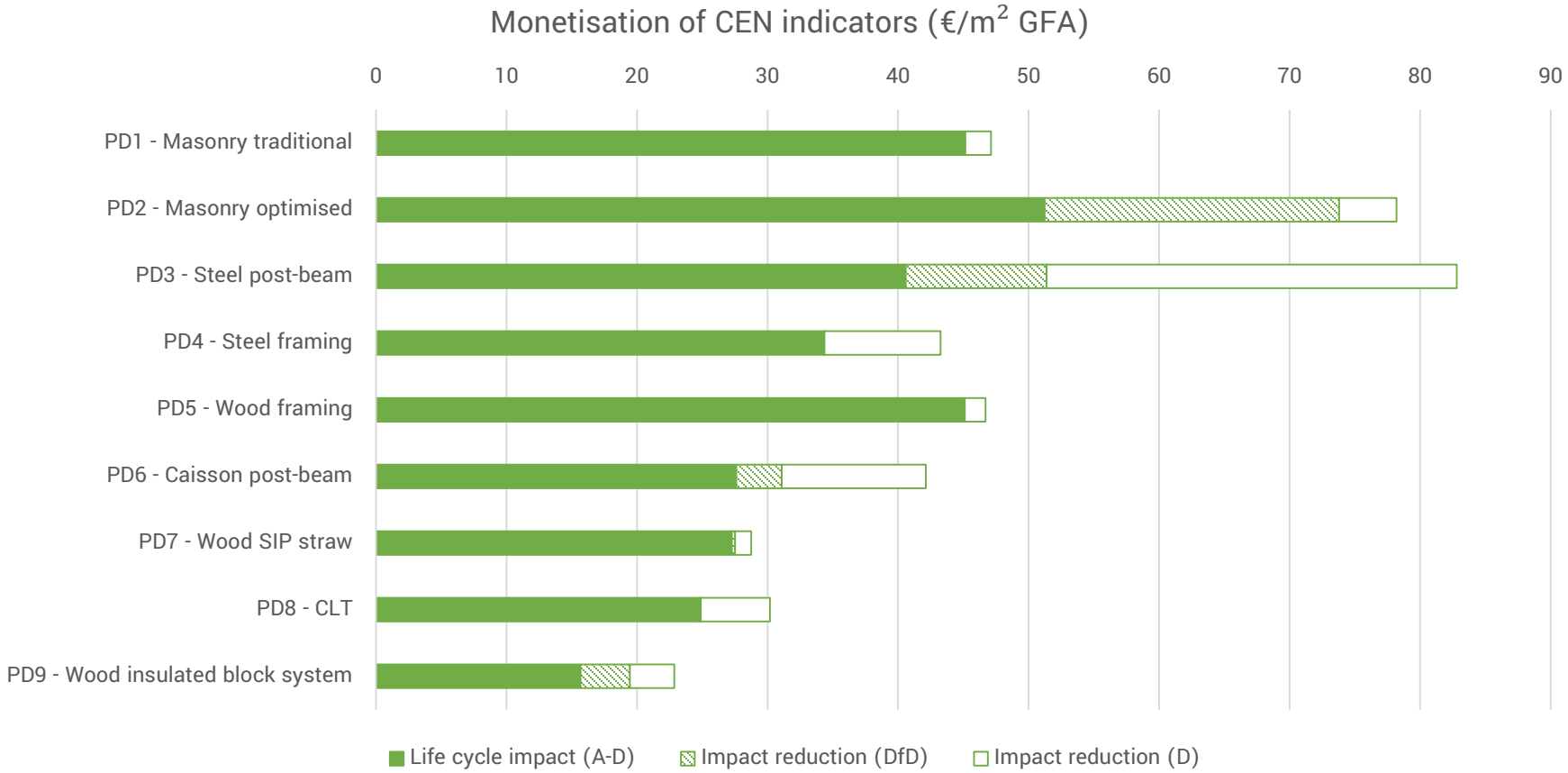


Results – Integration – CB’23 revised





Results – Integration – LCA revised



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Conclusions

It was observed that the EoL scenarios have significant impact on long-term decision making:

- Existing EoL percentages depending on business-as-usual do not represent the reuse and recycling potential.
- Available circularity tools can provide insight on these potentials.
- Integrated LCA results show that new assumptions on circularity potential have significant impact on impact assessment.

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Projectpartners

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