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BIMMATERIAL

Concept for a BIM-based Material Passport for buildings

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SBE19 Brussels - BAMB-CIRCPATH
05-07 February 2019

BAMB
BUILDING AS MATERIAL BANKS

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 642384.

BIMaterial

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- Research project „BIMaterial: Process-Design for a BIM-based Material Passport“
- Project duration: 01/2016 – 05/2018
- Funded by the Austrian Ministry for Transport, Innovation and Technology
- Project partners from TU Vienna and industry

bi.ibpm bi.iwr AQNULL Bausoftware GmbH ATP sustain

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Point of departure

- Buildings in the EU are responsible for 50% of all extracted materials and for 35% of greenhouse gas emissions [1]
- The construction sector is the largest consumer of raw materials [2]
- Aim of the EU: reducing waste, using less virgin materials and increasing recycling rates[3]

⇩

Consumption of raw materials needs to be reduced in the building industry

- **Information about the material composition of buildings is required!**

[1] European Commission, Roadmap to a Resource Efficient Europe, Brussels, 2011
[2] WEF, World Economic Forum, Shaping the Future of Construction: A Breakthrough in Mindset and Technology, 2016
[3] European Commission, Commission Decision, 2011

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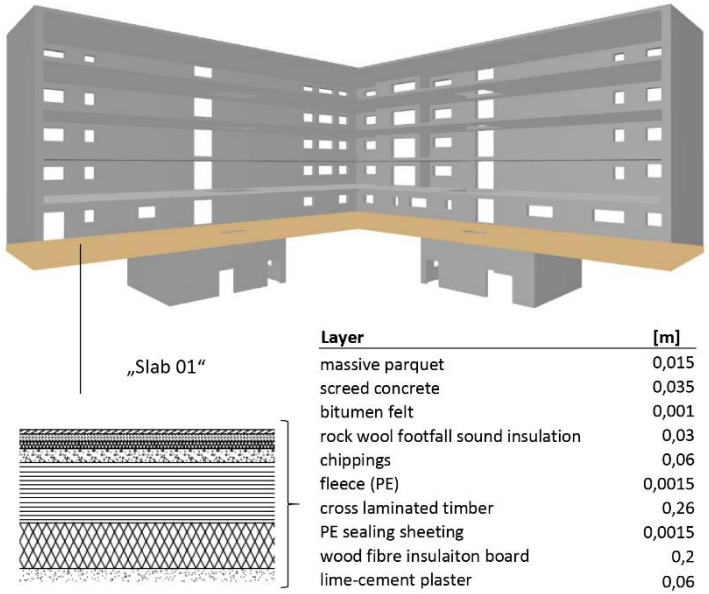
What is a Material Passport (MP)?

A qualitative and quantitative documentation of the material composition of a building showing the material distribution within a building

- Allocation of materials
- Amount of materials (masses)
- Share of recyclable and waste materials
- Environmental impact of materials
- Separability of materials



Layer	[m]
massive parquet	0,015
screed concrete	0,035
bitumen felt	0,001
rock wool footfall sound insulation	0,03
chippings	0,06
fleece (PE)	0,0015
cross laminated timber	0,26
PE sealing sheeting	0,0015
wood fibre insulaiton board	0,2
lime-cement plaster	0,06

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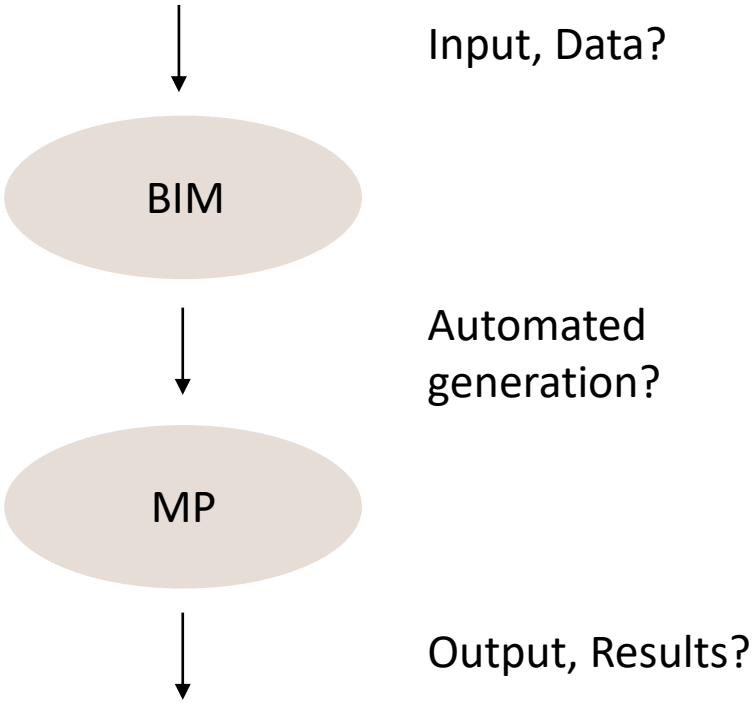
Aim of this research

- Process-Design for a BIM-based Material Passport
- Is a BIM-based and automated generation of a Material Passport possible?



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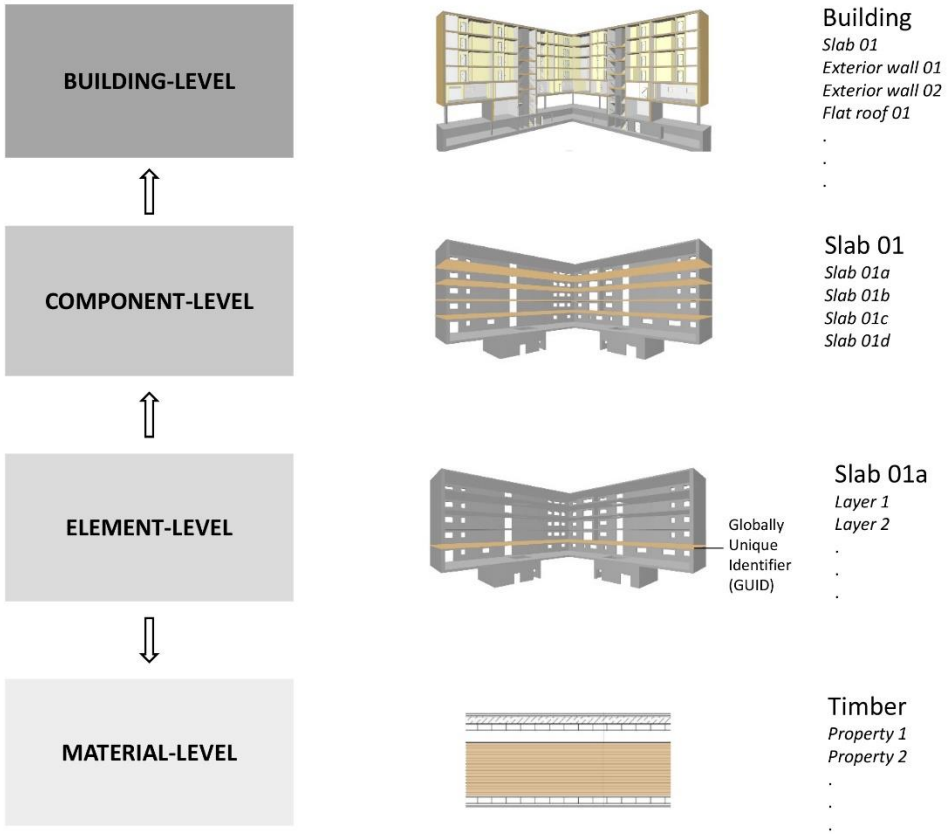
Framework for the BIM-based MP

- Mix of bottom-up and top-down approach, starting at element-level
- Based on Markova and Rechberger (2011)



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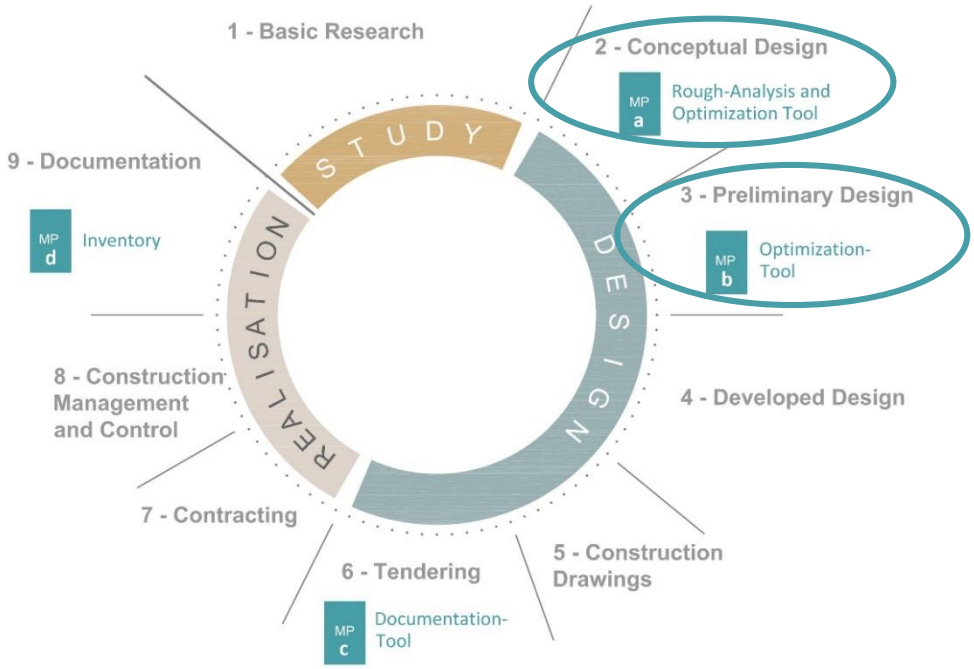
Scope of the BIM-based MP throughout the life-cycle

- **MPa**: Rough analysis and optimization tool, variant studies (timber vs. concrete)
- **MPb**: optimization of the selected variant (thickness of layers, material)
- **MPc**: documentation of the exact material composition
- **MPd**: basis for a secondary raw materials cadastre



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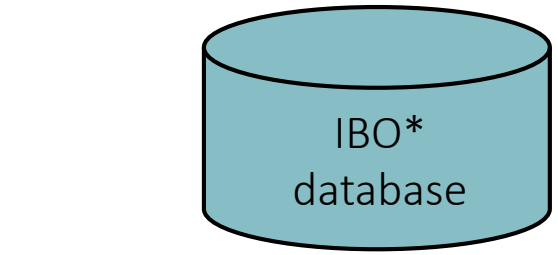
Method and data



Consistent data!

Eco-data (eco2soft)

- Global Warming Potential (GWP)
- Acidification Potential (AP)
- Primary Energy Intensity

Recycling-data (eco2soft)

Recycling grade	Recycling	Waste
1	75%	25%
2	50%	50%
3	25%	75%
4	0%	100%
5	0%	125%

Building elements (baubook)

- Concrete outside wall
- Cross laminated timber outside wall etc.

IBO, Austrian Institute for Building and Ecology
http://www.ibo.at/de/oekokennzahlen.htm

Eco2soft: https://www.baubook.info/eco2soft/
Baubook: http://www.baubook.info/index.php

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Method and data

- Assessing the **share of recycling** for a specific material (concrete) in a wall of 1m²(based on the IBO method):

density *(eco2soft)* * ***thickness*** *(baubook/BIM)** ***area*** *(BIM)* * ***recycling grade*** *(eco2soft)*

2300 *[kg/m³]** ***0,18*** *[m]* * ***1*** *[m²]* * ***50%*** *[grade 2]* = ***207 kg***

Separability is not considered in the IBO method –

partly manual process necessary (pre-defined elements)

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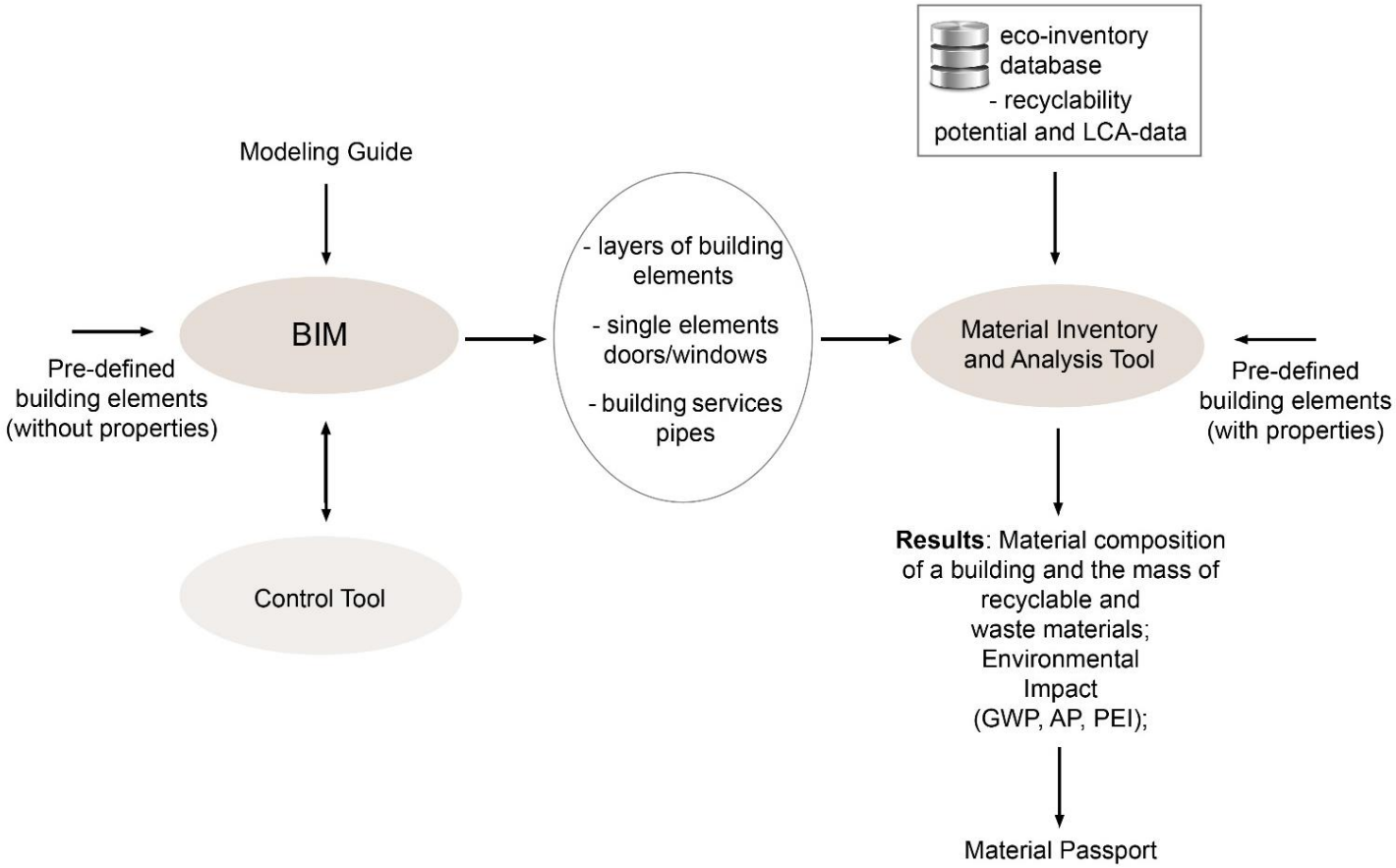
Workflow for generating the MP



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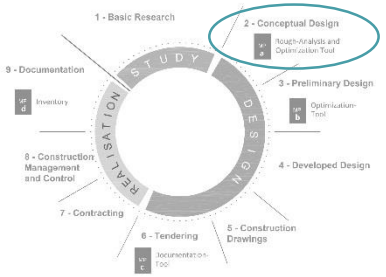
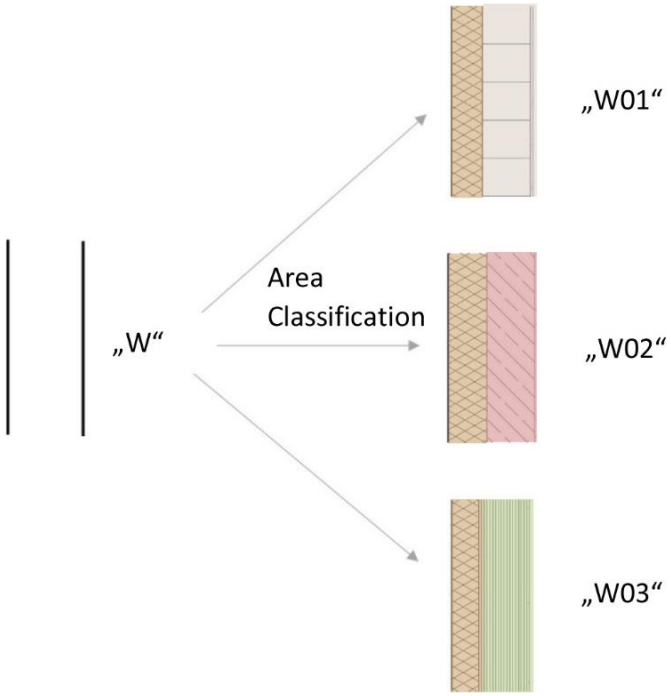
Modelling methodology for MPa



BIM
Mono-layered elements without properties

Material inventory and analysis tool
Multi-layered elements with properties (MP- and LCA- data)



Possibility to carry out variant studies

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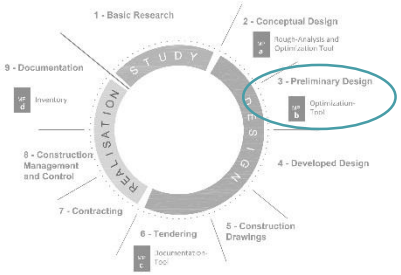
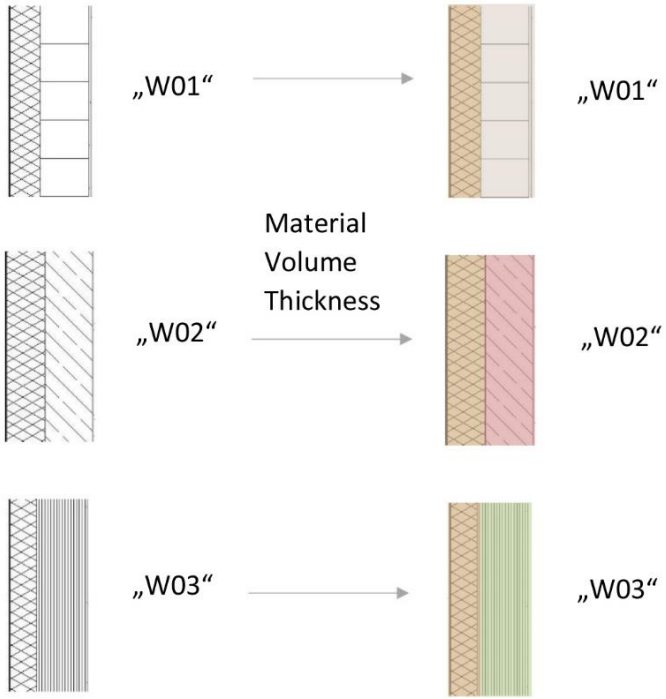
Modelling methodology for MPb



BIM
Multi-layered elements without properties

Material inventory and analysis tool
Multi-layered elements with properties (MP- and LCA- data)



Possibility to make small changes in the thickness or a specific material

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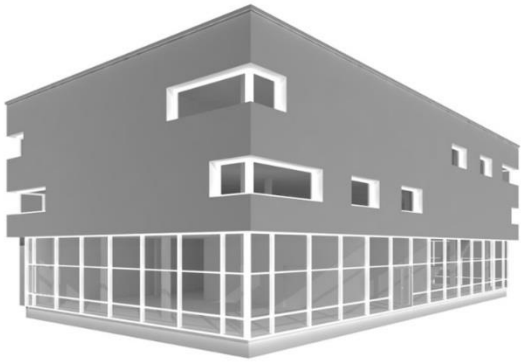
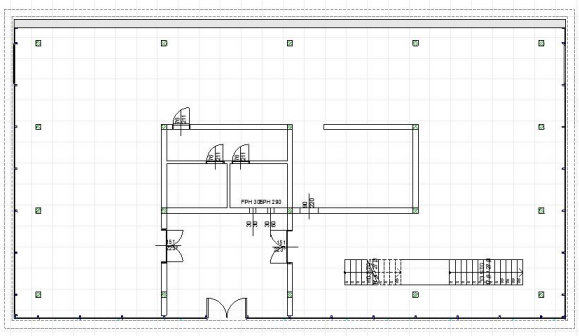
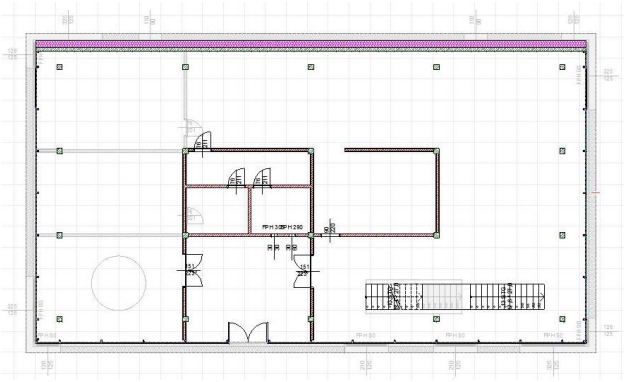
Case study: office building

- Existing model of the building
- 3 storeys
- Concrete construction





Mono-layered elements
(for Mpa)



Mono-layered elements replaced by multi-layered elements from the cataolgue (for MPb)

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MP-results

RECYCLING POTENTIAL OF THE BUILDING

	Recycling grade	Share of recycling (t)	Share of waste (t)
1 (86 - 100%)			
1,5 (72 - 86%)			
2 (58 - 72%)			
2,5 (44 - 58%)	2,5	638	700
3 (31 - 44%)			
3,5 (17 - 31%)			
4 (3 - 17%)			
4,5 (-11 - 3%)			
5 (-25 - -11%)			

DISPOSAL INDICATOR OF THE BUILDING *

	Disposal Indicator (EI)
1	
1,5	1,5
2	
2,5	
3	
3,5	
4	
4,5	
5	

* Disposal indicator is element-based and area weighted, it considers the volume, disposal- and recycling- grade.

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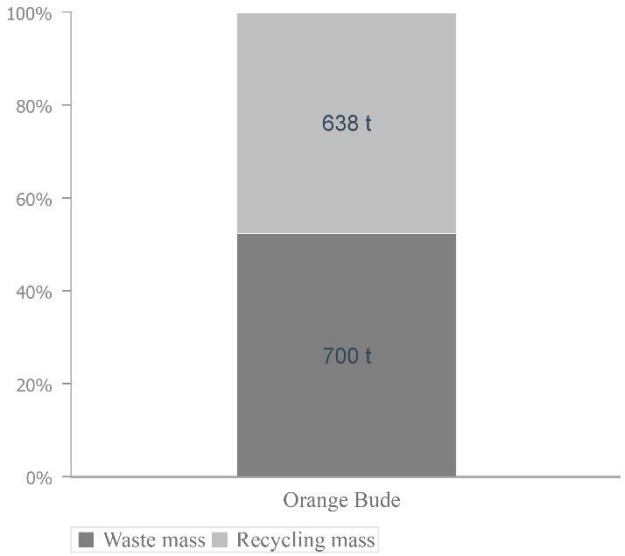
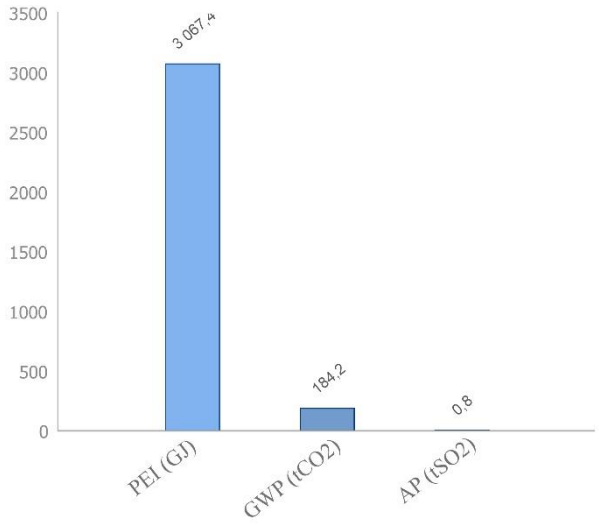
MP-results on building level

Waste vs. Recyclable mass



LCA



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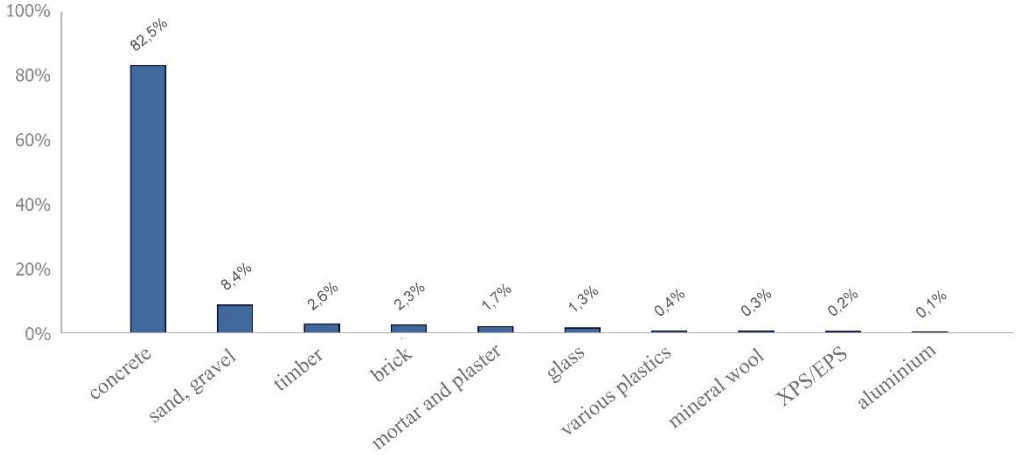
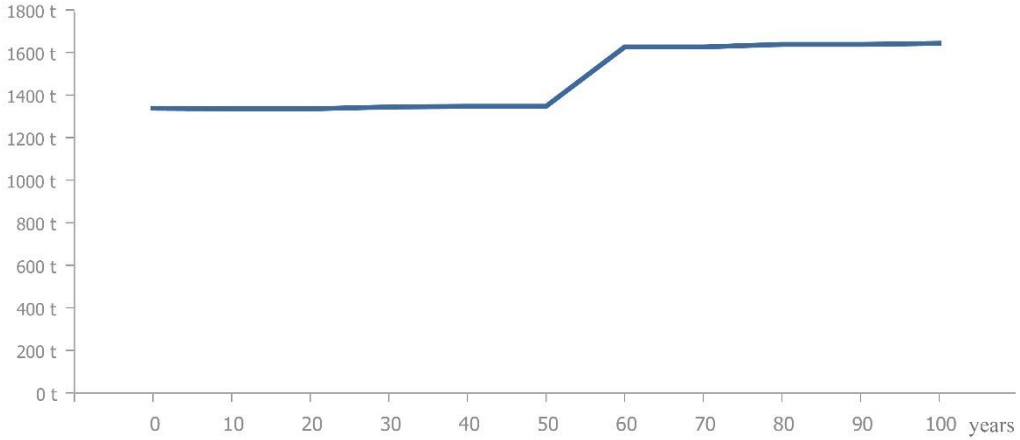
MP-results on building level

Material composition in %



Accruing masses throughout the life-cycle (t)



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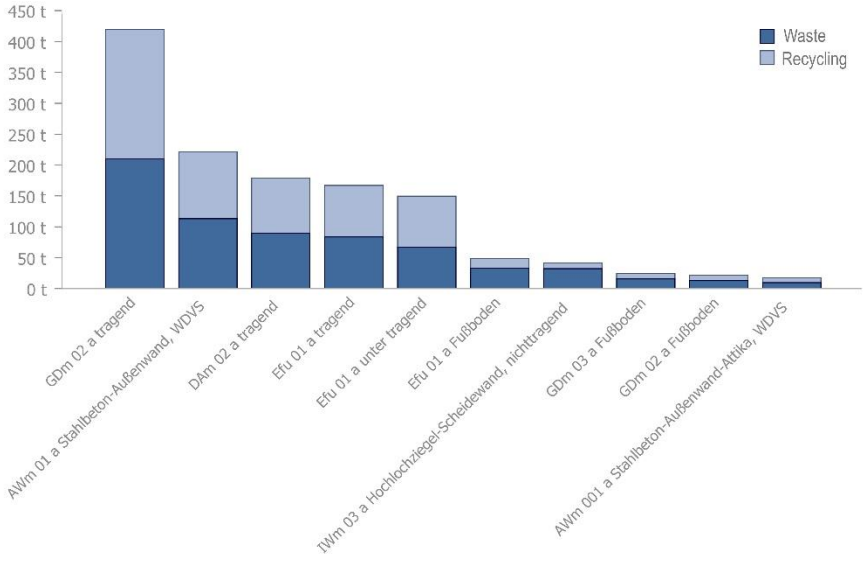
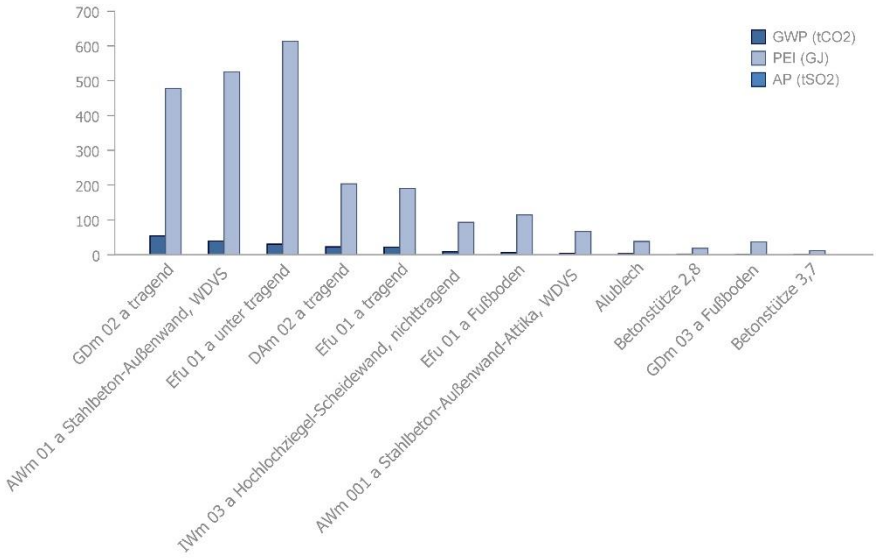
MP-results on compenent level

Waste vs. Recyclable mass



LCA



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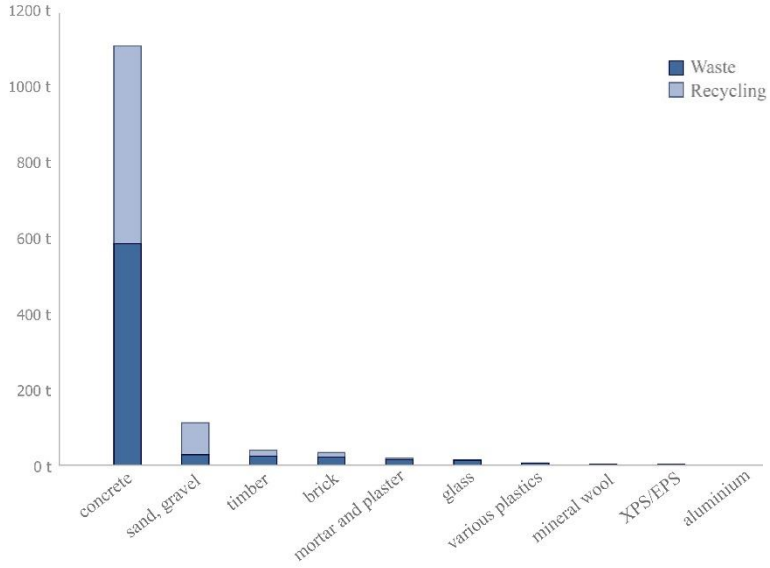
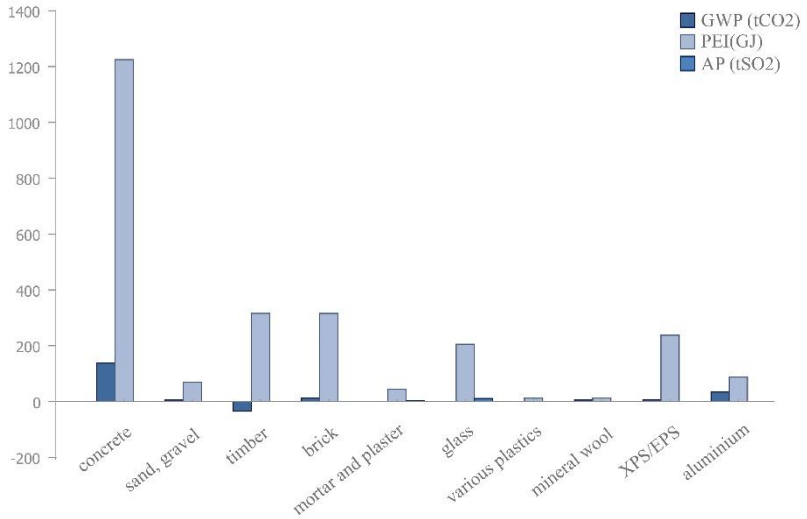
MP-results on material level

Waste vs. Recyclable mass



LCA



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Conclusions

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Main obstacles:

- **Inconsistent nomenclature** in different eco-databases
- In early design stages the **material composition is not defined** yet, therefore the use of pre-defined elements is necessary – restriction for planners
- **Parametrization** of materials in BIM is **not possible** in a consistent way, therefore the Material Inventory and Analysis Tool was used - requires specific know-how
- Knowledge regarding materials and sustainability necessary - „MP-consultant“

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Conclusions

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- Semi-automated generation of the BIM-based MP is possible
- MP enables optimizations in early design-stages
- MP represents a vital contribution to implement circular solutions within the AEC industry
- Basic method (from IBO) could be improved and enriched with data
- New construction rate across Europe is 2% - generation of MPs for existing buildings necessary (research project SCI_BIM)

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Publications

- Publications to BIMaterial:
  - Honic, M., Kovacic, I., & Rechberger, H. (2019). Improving the recycling potential of buildings through Material Passports (MP): An Austrian case study. *Journal of Cleaner Production*.
  - Honic, M., Kovacic, I., & Rechberger, H. (2019). BIM-Based Material Passport (MP) as an Optimization Tool for Increasing the Recyclability of Buildings. In *Applied Mechanics and Materials* (Vol. 887, pp. 327-334). Trans Tech Publications.
  - Honic, M., Kovacic, I., Sibenik, G., & Rechberger, H. (2019). Data-and stakeholder management framework for the implementation of BIM-based Material Passports. *Journal of Building Engineering*.

- Information and final report of BIMaterial:
  - https://www.industriebau.tuwien.ac.at/forschung/forschungsprojekte-i-p/bimaterial/

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New research project

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SCI_BIM

- SCI_BIM – Scanning and data capturing for Integrated Resources and Energy Assessment using Building Information Modelling

- Information to SCI_BIM:
  - https://www.industriebau.tuwien.ac.at/forschung/forschungsprojekte-i-p/sci-bim/

- Contact:
  - meliha.honic@tuwien.ac.at

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