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LCA & BIM: how to ensure quality issues in such a context

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LCA Forum 77, April 21st, 2021



ETH zürich

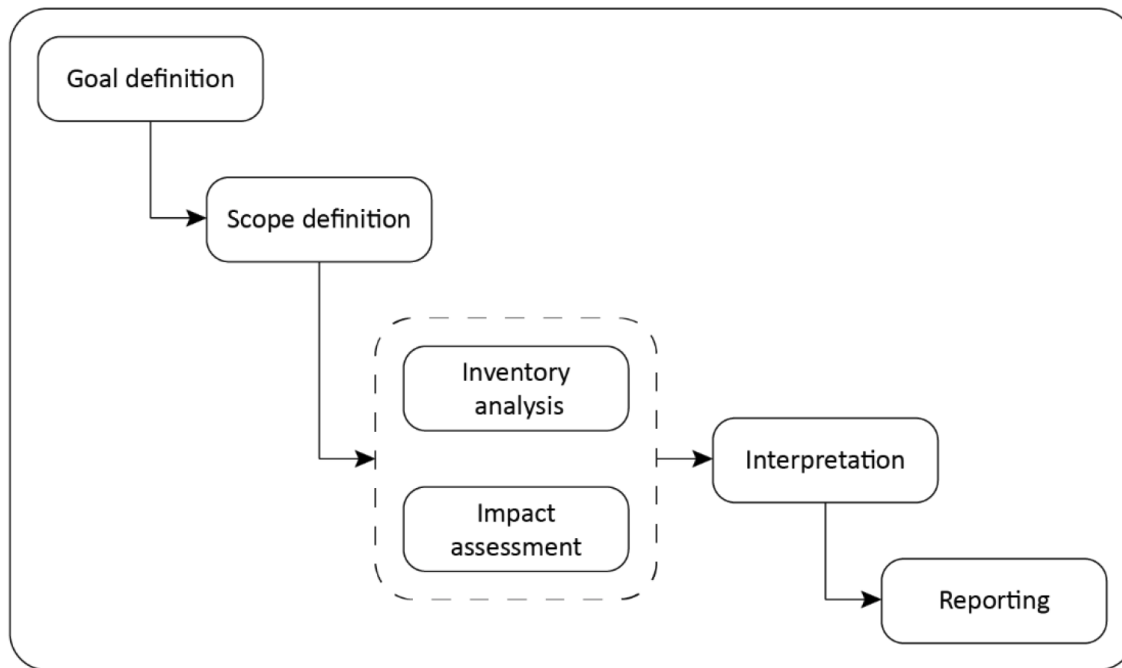


**IEA EBC Annex 72 - Assessing
Life Cycle Related Environmental
Impacts Caused by Buildings**

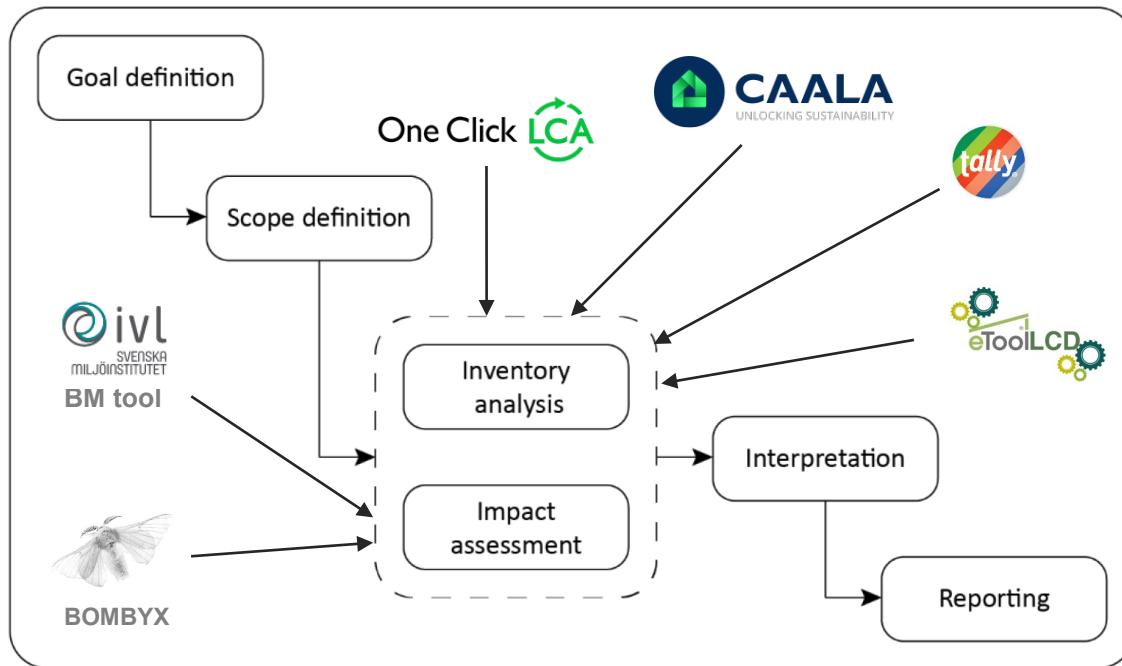




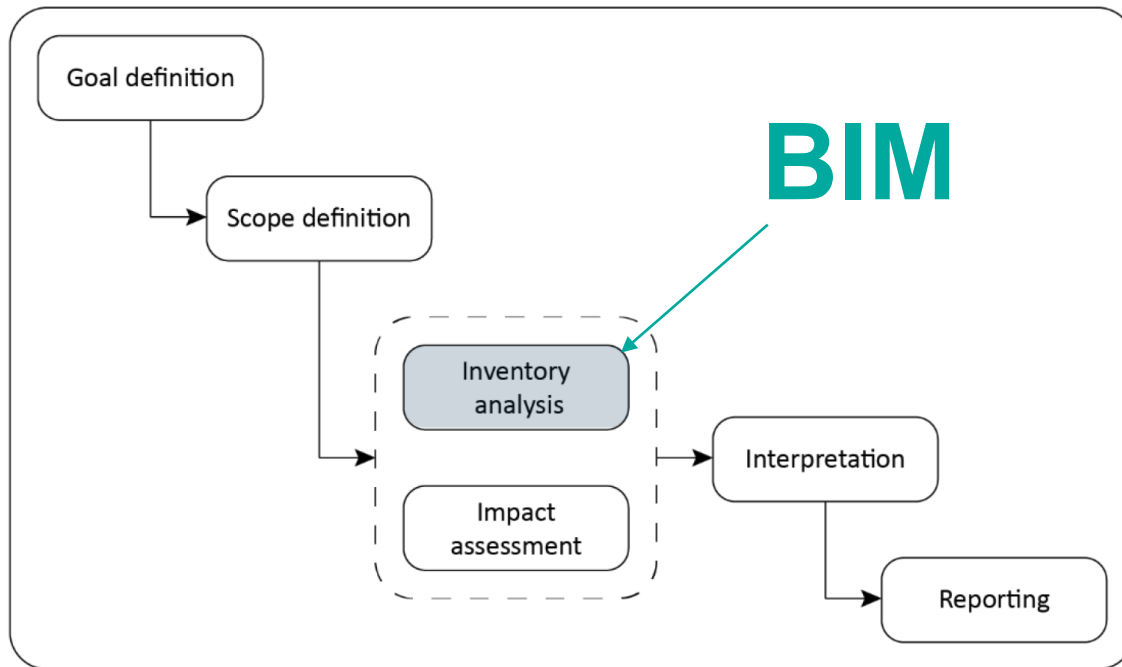
Phases of LCA



Phases of LCA

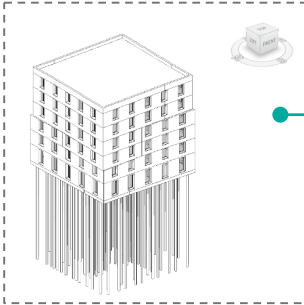


Phases of LCA



Detailed BIM

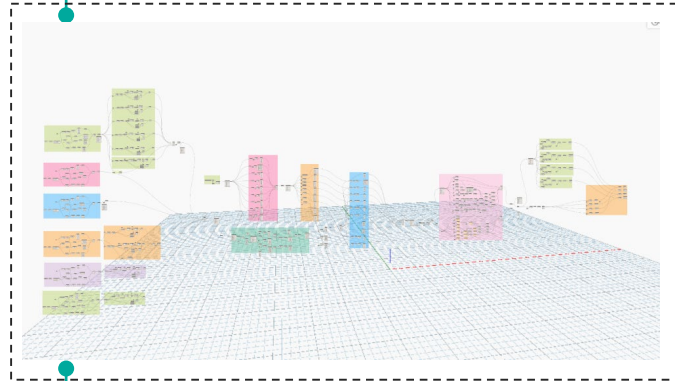
BIM model



Geometrical data



Dynamo for LCA calculations



KBOB data

KBOB / Acco-bau / IPB 2009/1 2016										
Substruktur Material maße	KBOB Kategorie	KBOB Gruppe	LSP			KBOB/ACC Kategorie			KBOB/ACC Gruppe	
			Maße	Einheit	Wert	Maße	Einheit	Wert	Maße	Einheit
100	100	100	100	100	100	100	100	100	100	100
1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000
100000	100000	100000	100000	100000	100000	100000	100000	100000	100000	100000
1000000	1000000	1000000	1000000	1000000	1000000	1000000	1000000	1000000	1000000	1000000
10000000	10000000	10000000	10000000	10000000	10000000	10000000	10000000	10000000	10000000	10000000
100000000	100000000	100000000	100000000	100000000	100000000	100000000	100000000	100000000	100000000	100000000

LCA data



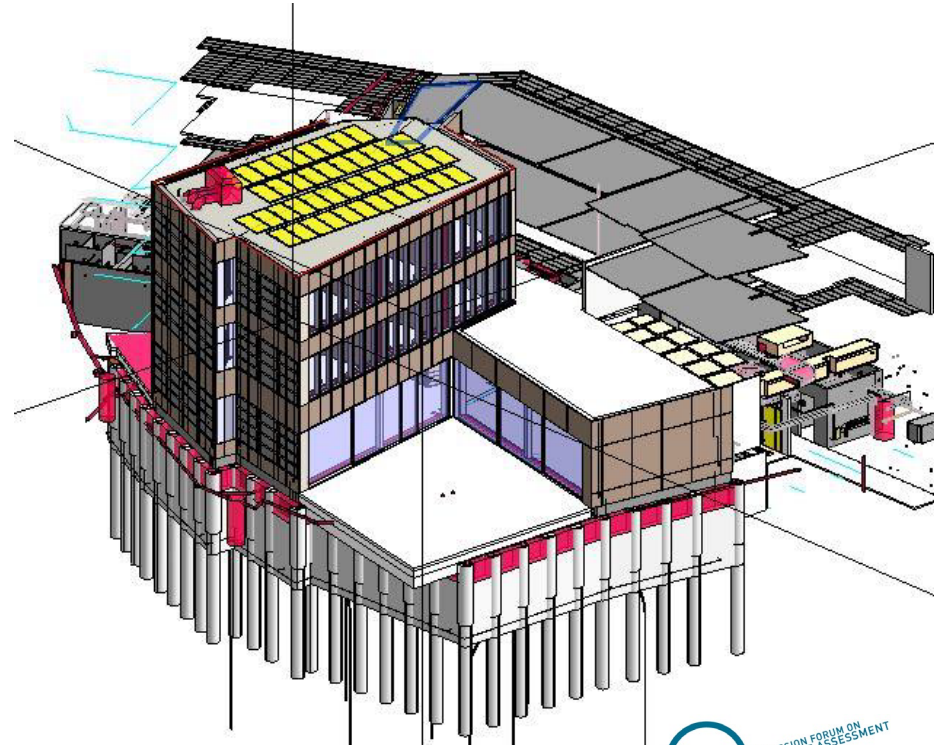
Case Study

- Basler & Hofmann GHA
- First building in Switzerland to be built without printed plans
- AEC Excellence Award 2018

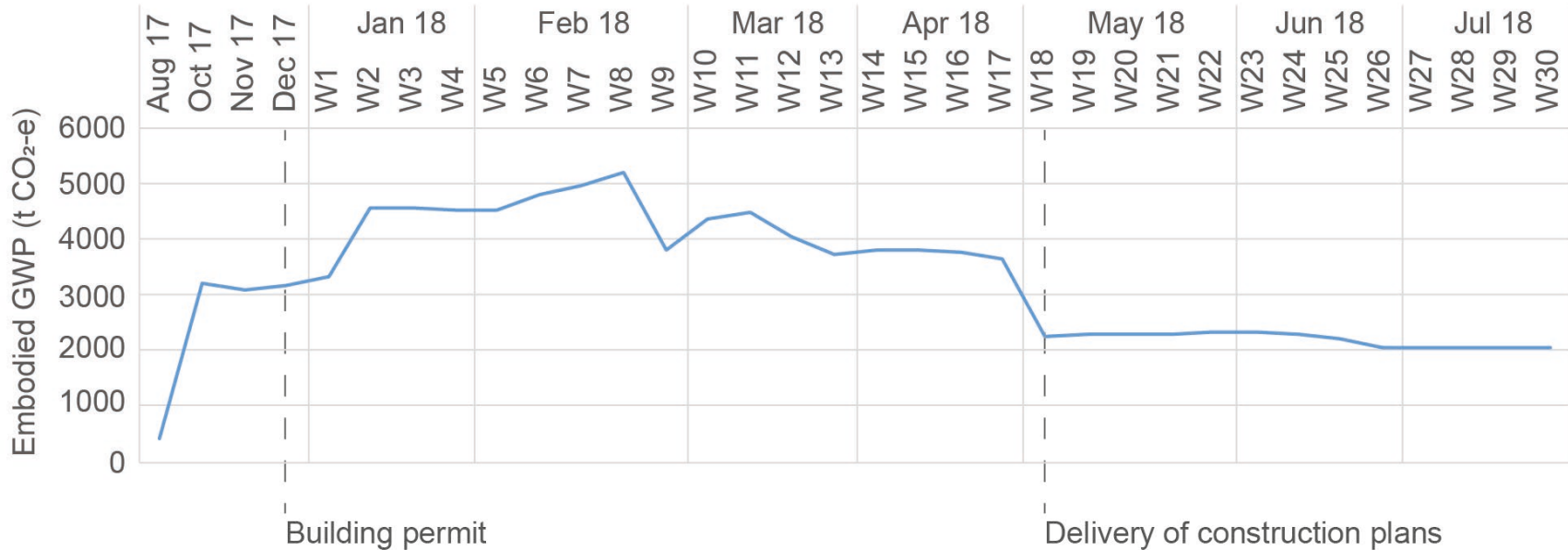


Case Study

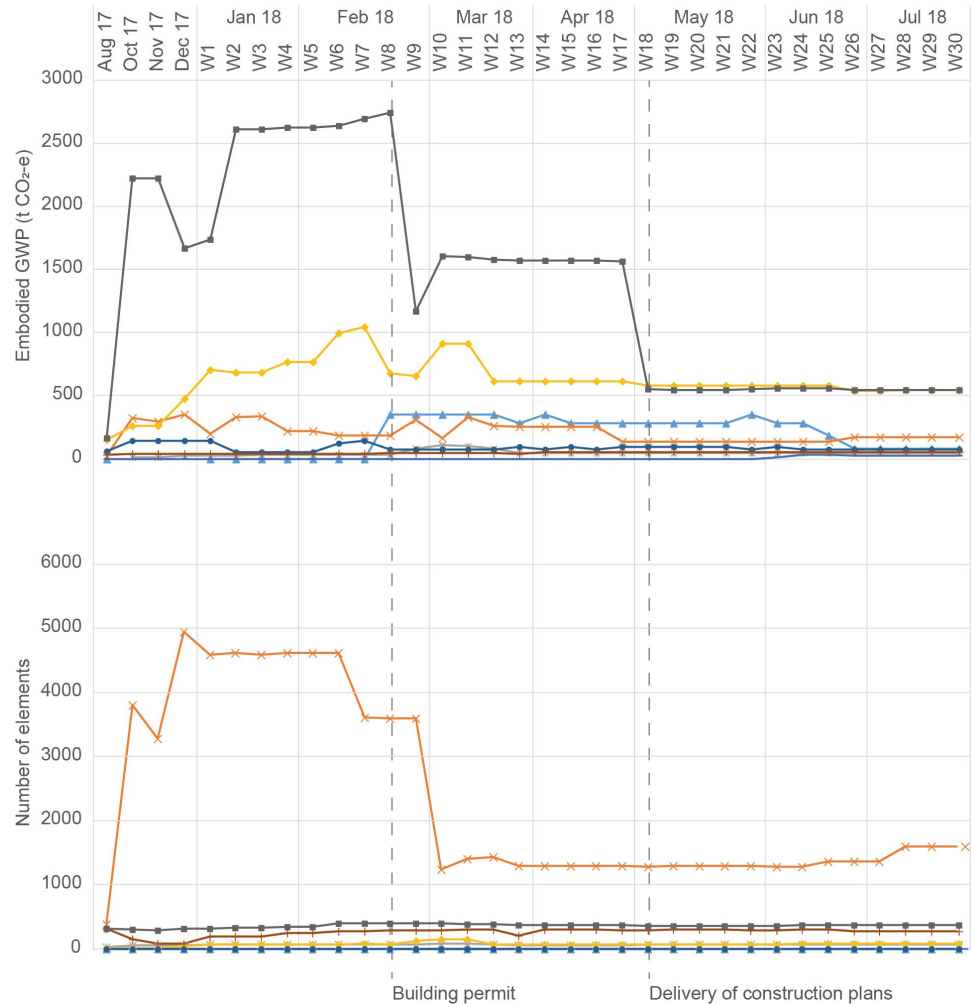
- "Freezing" and analysis of the model each week



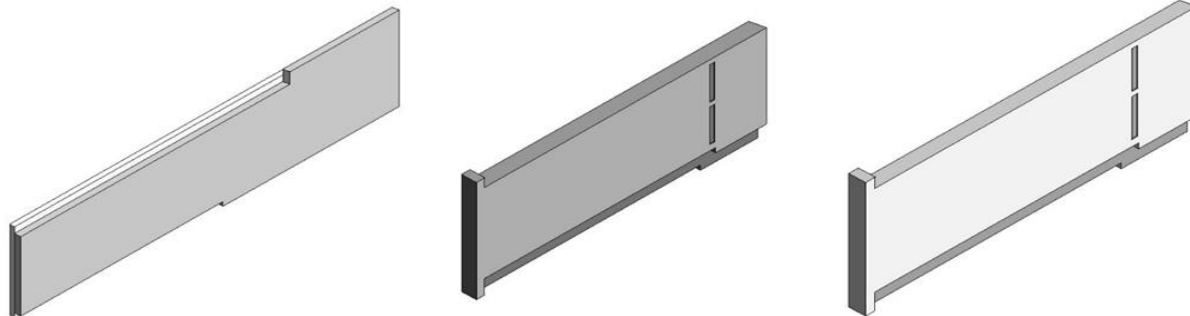
Results



Results

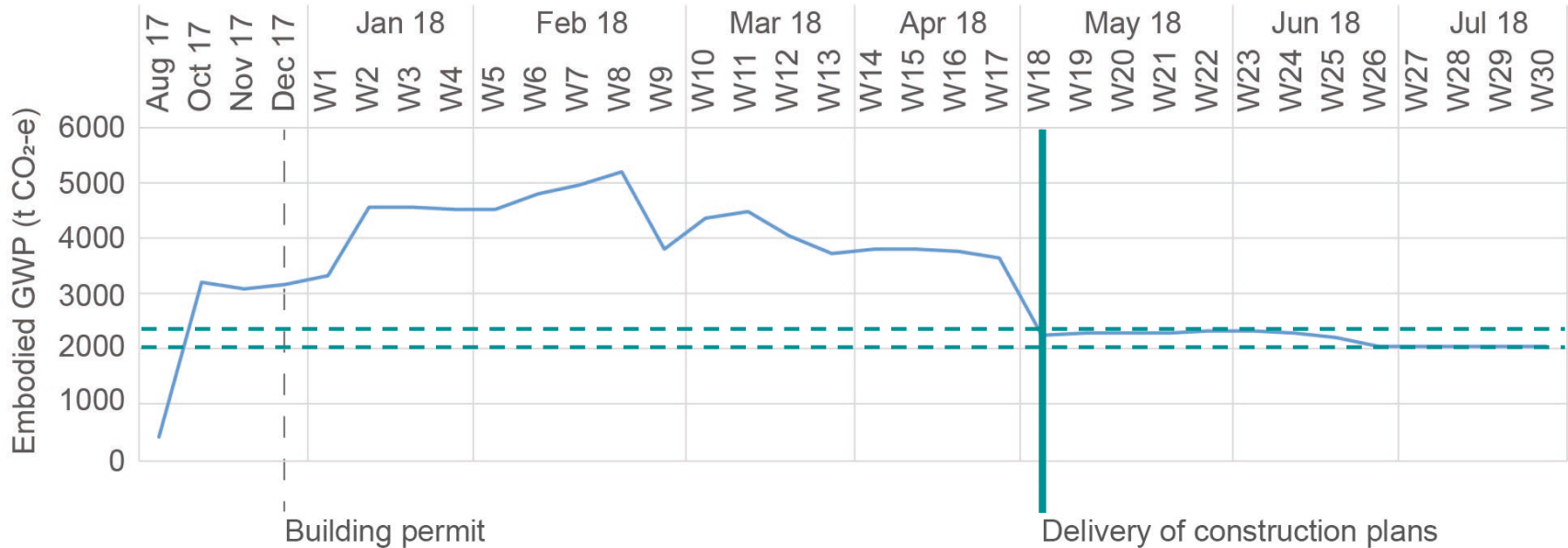


Model evolution

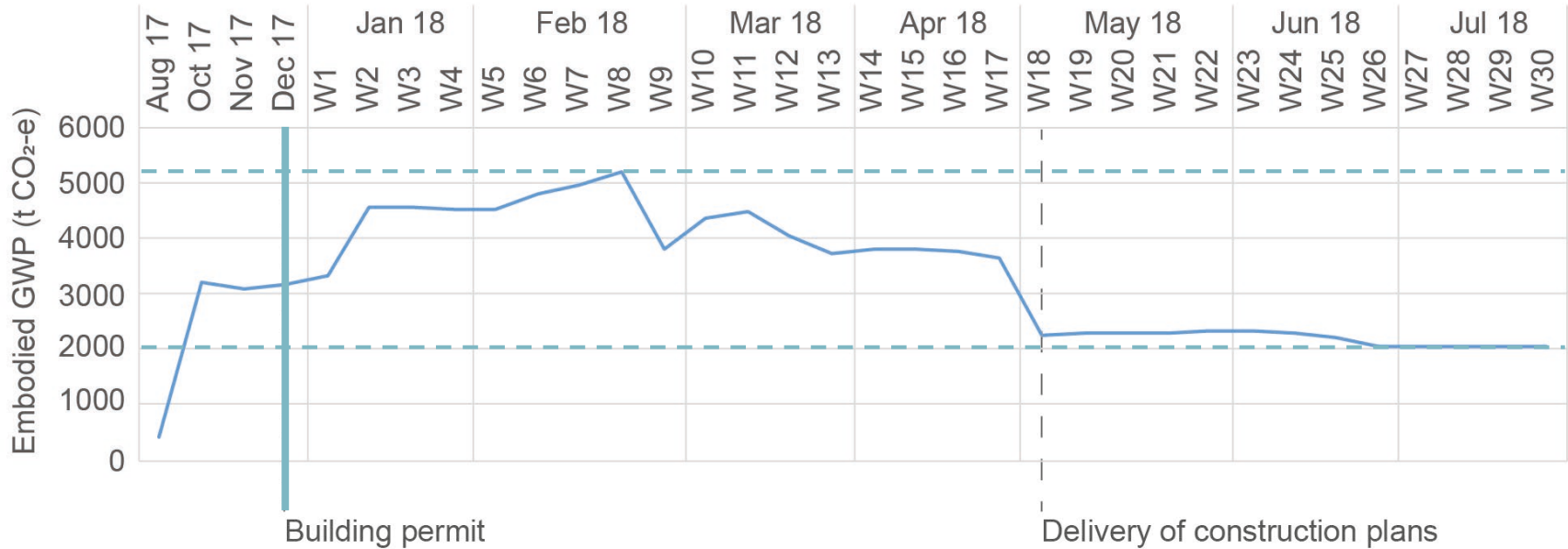


Date	October 2017	April 2018	July 2018
Number of elements	2	1	1
Number of materials	2	5	5
Area [m ²]	51.35	37.98	35.42
Volume [m ³]	12.82	18.79	11.45

Results



Results



Learnings

- Result only as accurate as the model
- Workflow based on placeholders
- Design integration difficult



Learnings

- Result only as accurate as the model
- Workflow based on placeholders
- Design integration difficult

Potential solutions:

- Adapt the design workflow
- Adapt the calculation methods for embodied impacts
- Use machine learning in LCA tools

Who can use LCA when and for what?



Brief

Concept

Detailed design

Construction

Use



Who can use LCA when and for what?

Brief

Concept

Detailed design

Construction

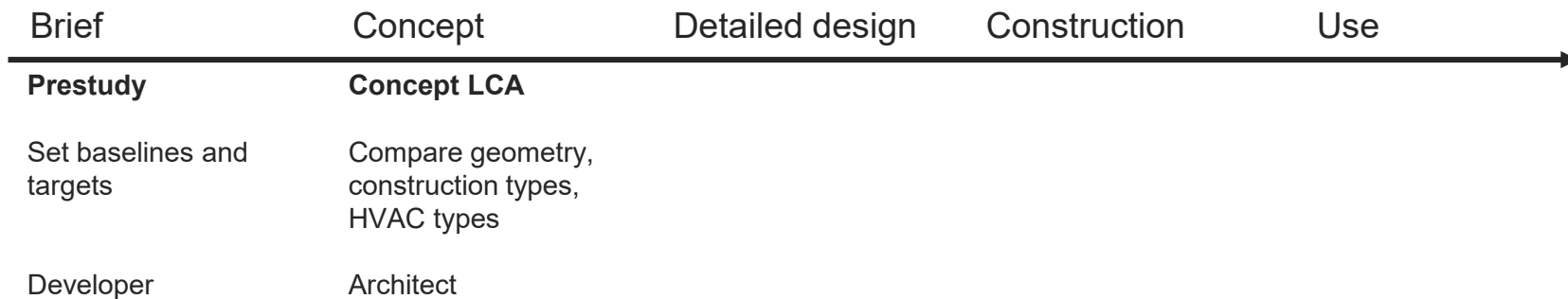
Use

Prestudy

Set baselines and
targets

Developer

Who can use LCA when and for what?



Who can use LCA when and for what?

Brief	Concept	Detailed design	Construction	Use
Prestudy	Concept LCA	Refined LCA		
Set baselines and targets	Compare geometry, construction types, HVAC types	Compare materials and manufacturers		
Developer	Architect	Engineer / contractor		

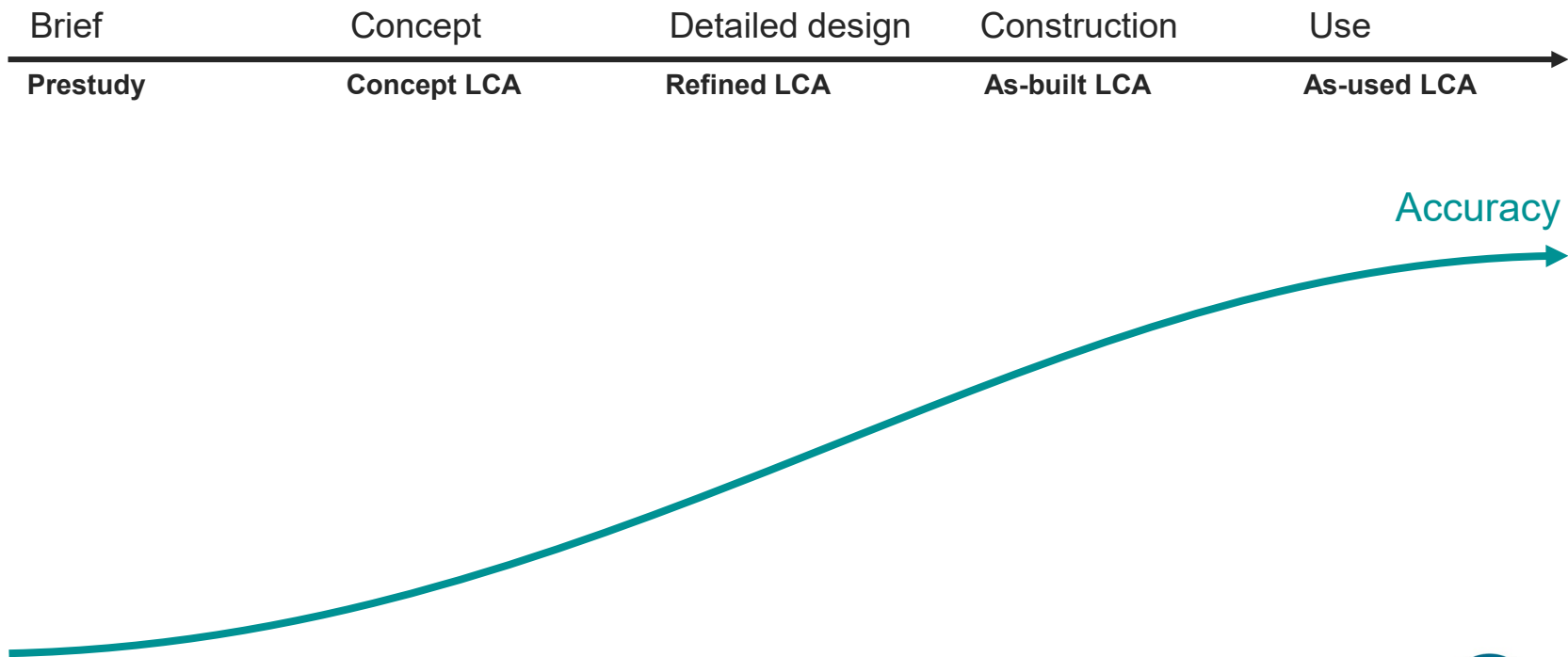
Who can use LCA when and for what?

Brief	Concept	Detailed design	Construction	Use
Prestudy	Concept LCA	Refined LCA	As-built LCA	
Set baselines and targets	Compare geometry, construction types, HVAC types	Compare materials and manufacturers	Document environmental impact	
Developer	Architect	Engineer / contractor	Contractor	

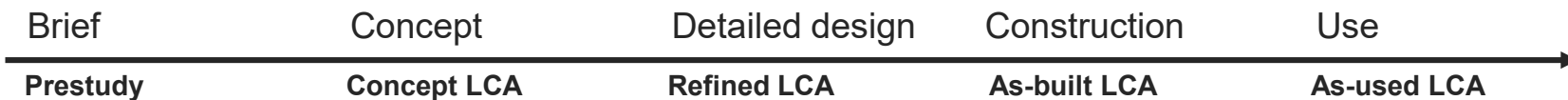
Who can use LCA when and for what?

Brief	Concept	Detailed design	Construction	Use
Prestudy	Concept LCA	Refined LCA	As-built LCA	As-used LCA
Set baselines and targets	Compare geometry, construction types, HVAC types	Compare materials and manufacturers	Document environmental impact	Learn from reality
Developer	Architect	Engineer / contractor	Contractor	Manager

Who can use LCA when and for what?

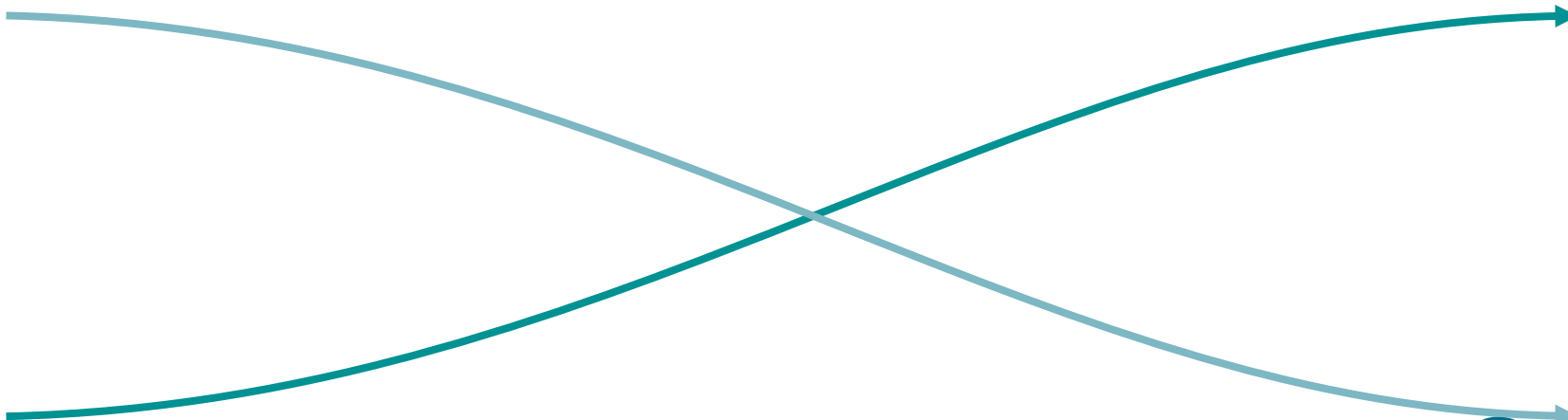


Who can use LCA when and for what?

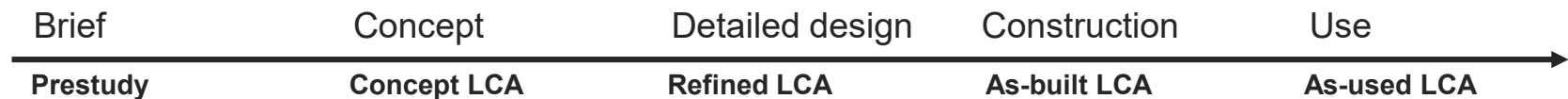


Optimisation potential

Accuracy



Who can use LCA when and for what?



Optimisation potential

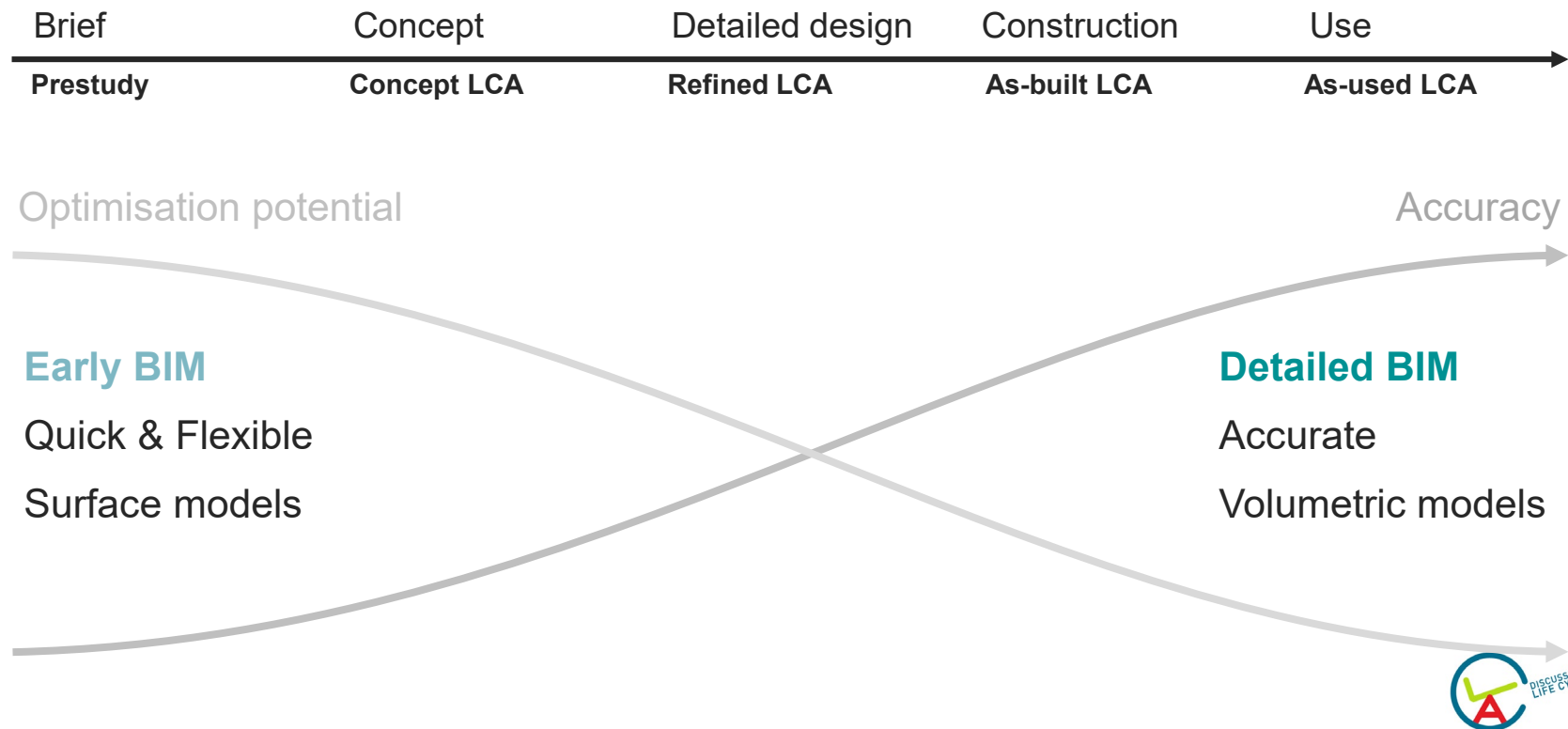
Accuracy

Early BIM

Quick & Flexible

Surface models

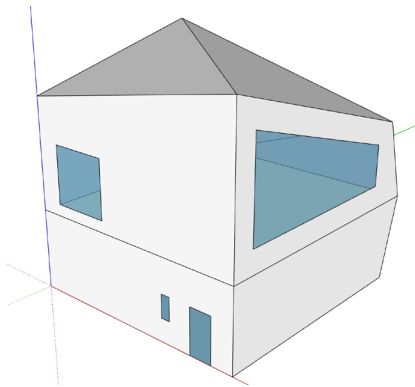
Who can use LCA when and for what?



Life Cycle Inventory

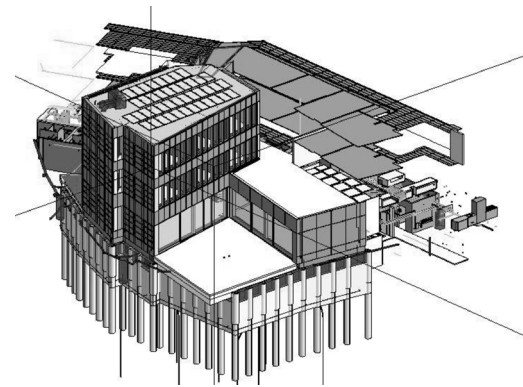
Early BIM

Surface model
Area take-off
Low LoG / high Lol



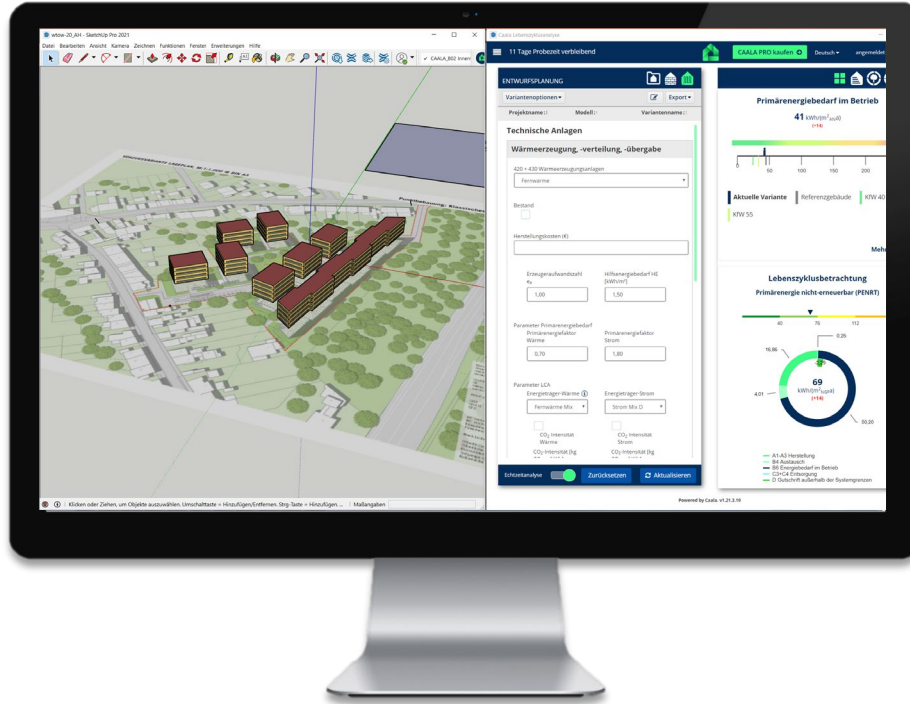
Detailed BIM

Volumetric model
Volume/mass take-off
High LoG / high Lol





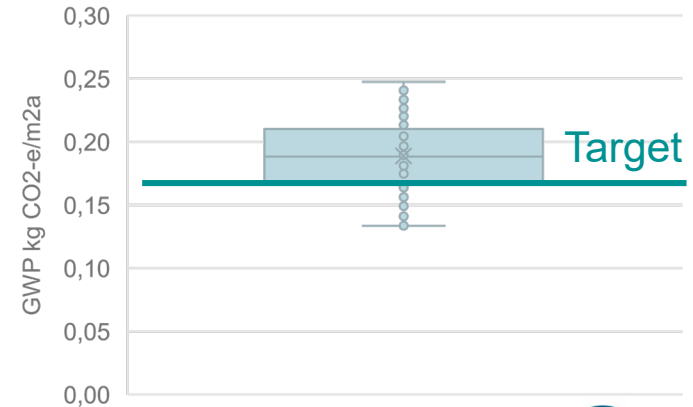
Example Brief




























- 4 Materials
- 3 Types of basement
- 3 Heating systems
- 3 WWRs
- 3 PV options



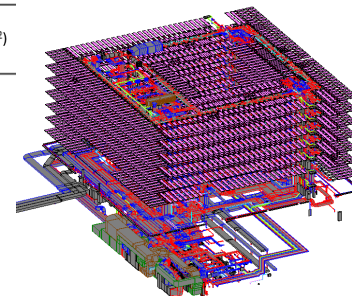
324
Combinations



Example as used LCA

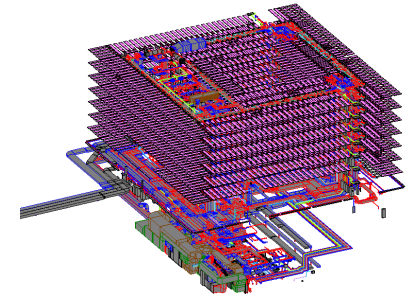
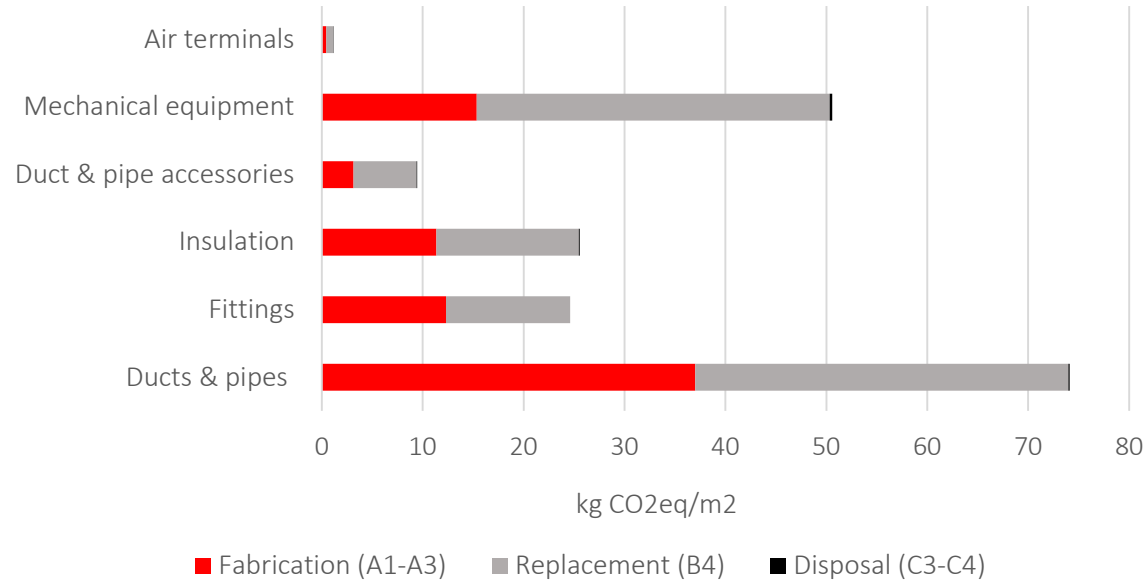
Name	Items	GWP (kg CO ₂ eq/m ²)	Name	Items	GWP (kg CO ₂ eq/m ²)	Name	Items	GWP (kg CO ₂ eq/m ²)
Hybrid Ceiling panel	 4'096	23.20	Grille	 453	0.60	Shut-off butterfly valve*	 205	1.38
Air Handling Unit (AHU)	 12	21.90	Diffuser	 164	0.50	Ball valve	 3569	0.38
Heat pump	 18	1.62	Poppet Valve	 243	0.04	Balancing valve**	 44	0.17
Chiller	 1	1.32				Strainer	 6	0.14
Heat exchanger	 5	1.27				Non-return valve	 29	0.11
Floor convector	 81	0.88	Multileaf damper***	 74	3.32	Circulating pump	 6	1.00
Recirculation cooler	 21	0.71	Volume flow controller***	 1293	2.92	Heat meter	 92	0.01
Fancoil unit	 7	0.12	Baffle silencer	 220	0.71	Adjustment valve	 23	0.01
Compressor, Endgaser	 3	0.05	Fire protection flap***	 401	0.29			
Vertical Heater	 28	0.03						

* with and w/o motor
 ** with and w/o sensor
 *** with actuator



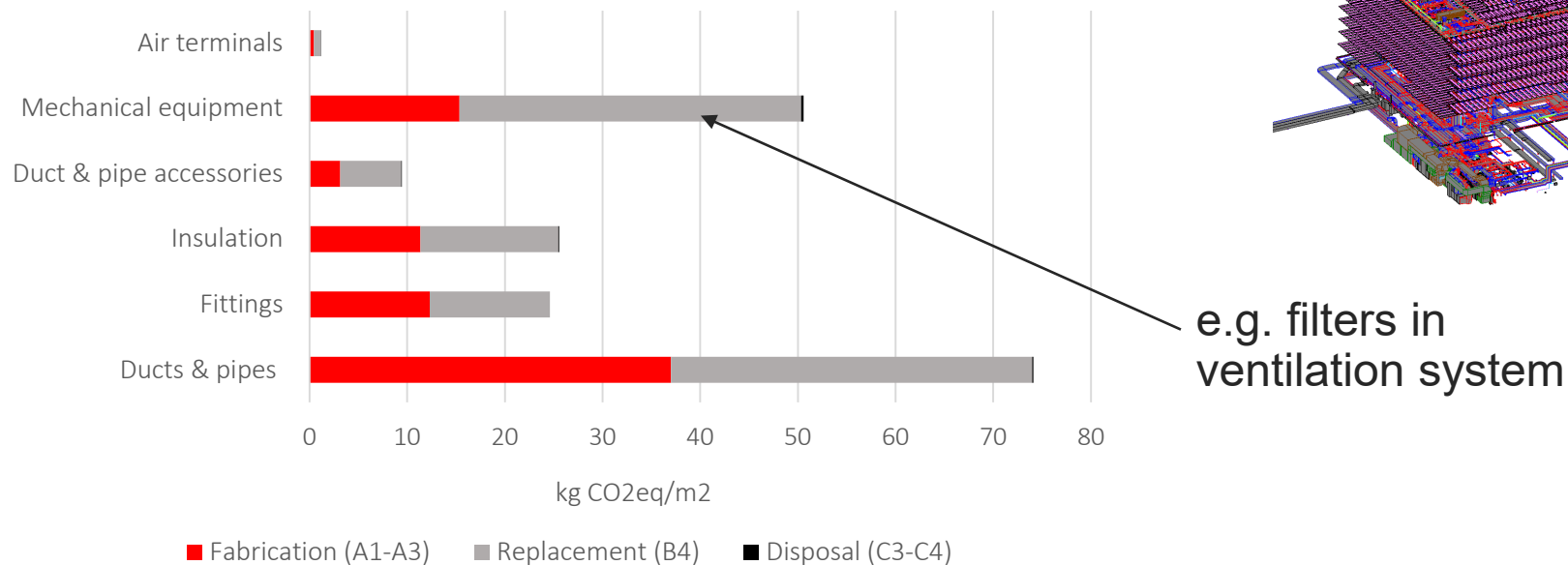
Example as used LCA

Climate change impact for the assessed HVAC categories

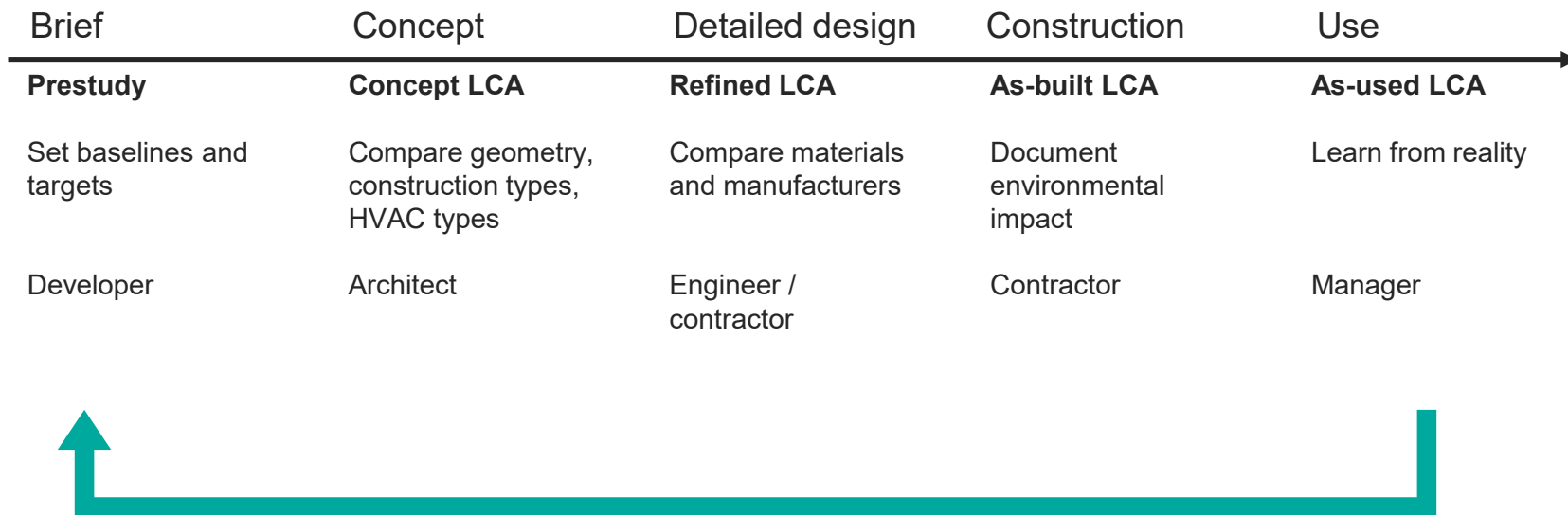


Example as used LCA

Climate change impact for the assessed HVAC categories



How can we learn for the future?



Example DGNB

- 838 LCAs of certified buildings (2015)
- 22 usable for benchmarks calculation



Energy & Buildings 194 (2019) 342–350

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LCA of buildings in Germany: Proposal for a future benchmark based on existing databases

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^bFraunhofer Institute for Building Physics (IBP), Department of Life-Cycle Engineering (GLE), Heinkelstraße 12, Stuttgart 70562, Germany

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ABSTRACT

The evaluation of environmental aspects in the early planning phase of buildings can support the reduction of the resource use and environmental impacts associated with the building sector over the whole building life-cycle. The integration of life cycle assessment (LCA) benchmarks in the planning phase is one potential measure. To derive these benchmarks a large database of existing building assessment is essential. Potential data sources are available from the German Sustainable Building Council (DGNB), as it certifies more than 200 buildings annually and the certification includes a mandatory LCA. In this study, the current submission files and databases of the DGNB are assessed and critically reviewed with regard to their usability for automated LCA benchmarks. First, a harmonized database is created from the large number of assessed buildings. Second, the data is examined for its suitability for benchmarking with regard to data format, structure and level of detail. The data that were declared fit for purpose were used to create an exemplary, harmonized data set with 22 office buildings. The evaluation of these data for various environmental indicators of the individual life cycle phases shows their respective relevance and can thus serve as a benchmark. Another focus is to encourage improvement of the additional documentation like the energy source required for better benchmarking, interpretation of results and auditing of the LCA rules for developing certification. The results of this study highlight the opportunities and challenges in the development of a database for benchmarking. Before long-term LCA benchmarks can be developed and deployed, a standardized and uniform submission format of results, that is independent regarding the used LCA software, needs to be developed. In the future the submission process should be extended by an automated quality assurance to prevent restraints from low data quality and data gaps that otherwise have to be detected manually.

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1. Introduction

The building and construction industry is held responsible for approximately 50% of the resource consumption, 33% of the energy consumption and about 35% of the greenhouse gas emissions worldwide [3]. The world's population is growing constantly and it is necessary to significantly minimize the environmental impact in this area in the future. Early planning phases of buildings offer a general opportunity to reduce long-term environmental impacts in the building industry, since the most important and far-reaching decisions are made at this stage [9,16]. However, early planning phases only sparse information on the planned buildings or components is available, whereas the necessary decisions in these phases are very complex [22,28]. Above all, innovative research and development is aimed at significantly reducing the resource requirements of future buildings. In order to make these ambitious targets achievable, benchmarks are needed as a starting point. Benchmarks, i.e. arithmetical averages of the life cycle assessment (LCA) results of realized assessed projects offer a good opportunity to receive information on environmental issues at an early stage. In addition, they can be used to specify target values for future buildings.

Currently, LCA is only used as proof for the buildings after project completion, because the process of conducting an LCA for buildings – data gathering, modelling and interpretation of the results – is very time-consuming and therefore cost-intensive [17].

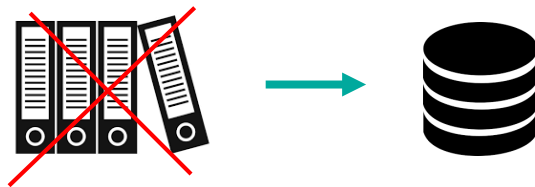
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Example DGNB

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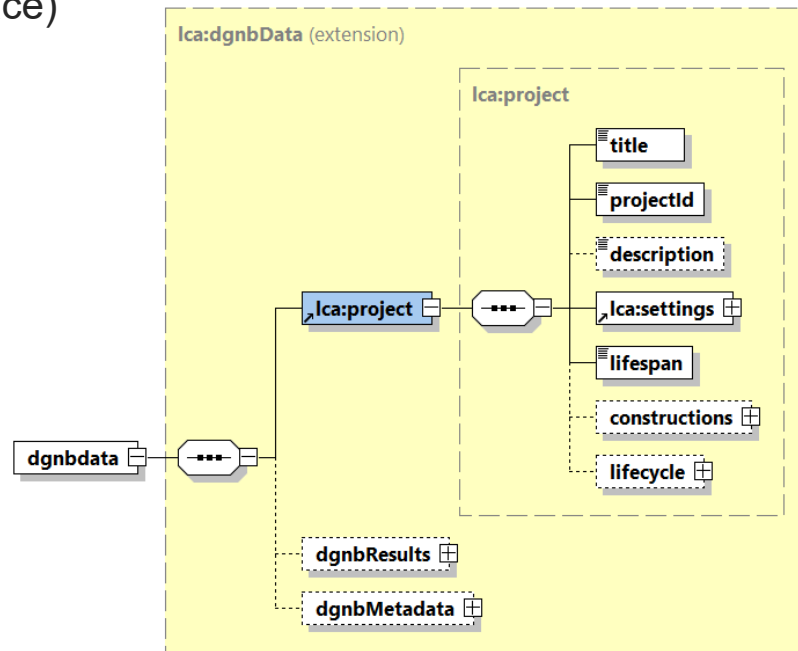
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Example DGNB

- Digital submission for certification (XML interface)

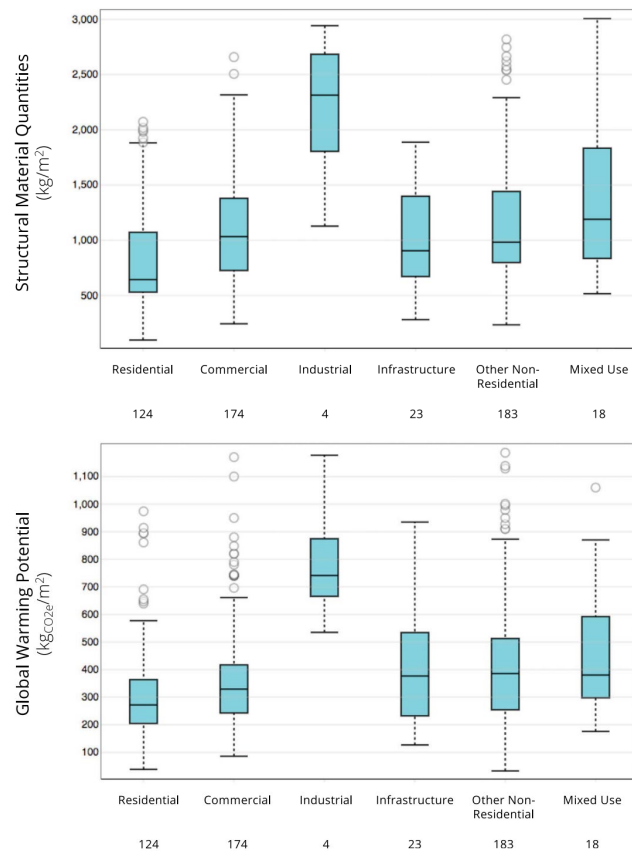




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Need for raw data

- BIM models / material quantities needed



Merci vilmal!



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alexander.hollberg@chalmers.se