IEA EBC Annex 72:
Assessing life cycle related environmental impacts caused by buildings

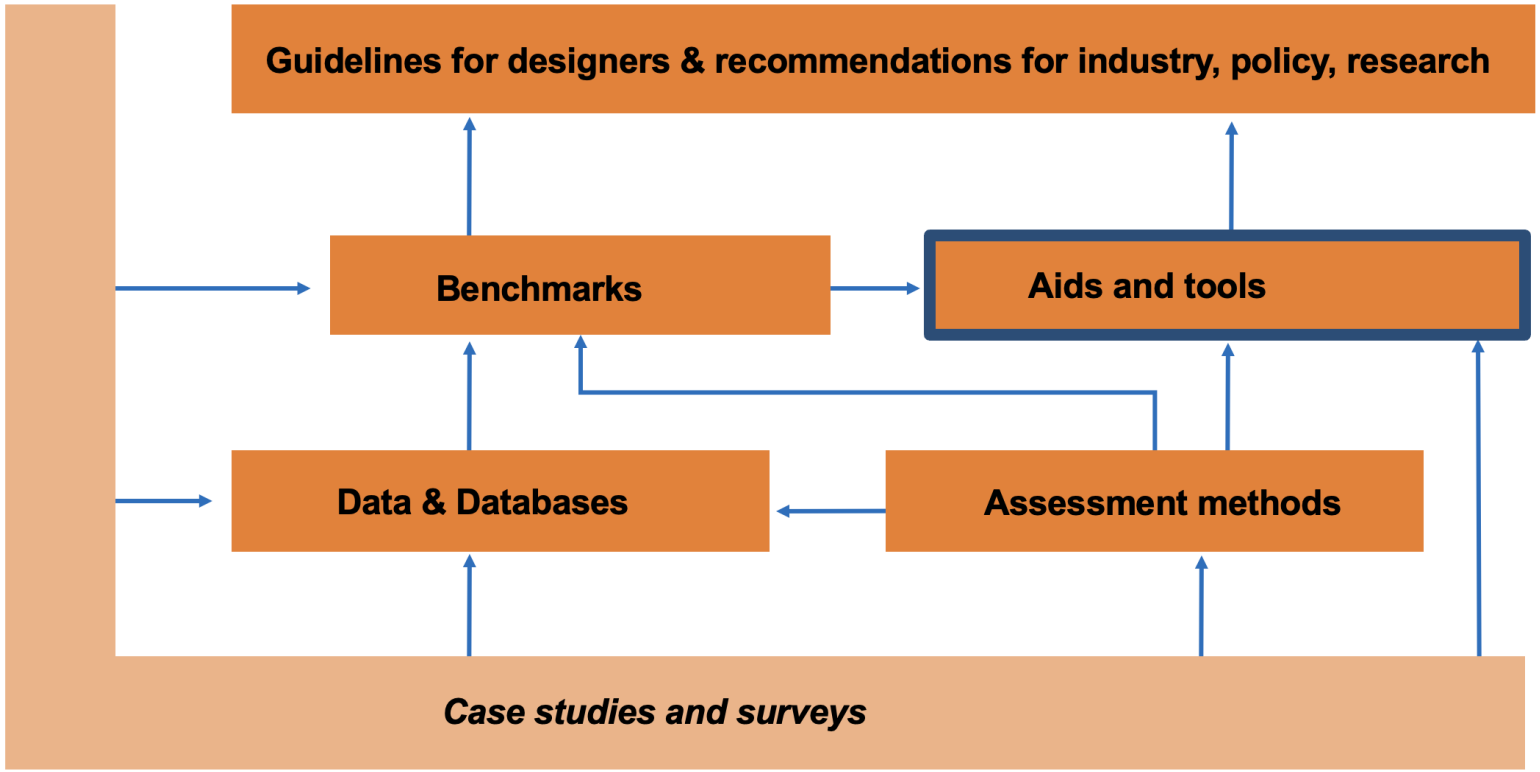
Life cycle assessment of buildings: requirements on aids and tools

Alexander Passer, Tajda Potrc Obrecht and Nicolas Bernard Jean Alaux
TU Graz, Austria
Leader of Subtask 2

Final event:
SBE ’22, Berlin, Germany, 21 September 2022

Context

The position of ST2 „Aids and tools“ and the interrelations to other ST’s and results



The “Aids and tools“ task provides a link between the Assessment methods and Data & Databases.

By harmonizing the methods and data the benchmarks can be set.

Target

Why we need aids and tools?

The building designers and person involved into the planning process are systematically guided through the design steps focusing on the following questions:

- How can the goal and scope of the LCA be linked with the design steps?
- How can the LCA inventory and the data involved in the LCA be organized?
- Which tools can be used?
- Which workflows can be used?
- How can design-related uncertainties be reduced in the workflow?
- How can LCA results be visualized, interpreted and communicated?

- **The purpose is to provide support to the design decisions-makers during the design process.**

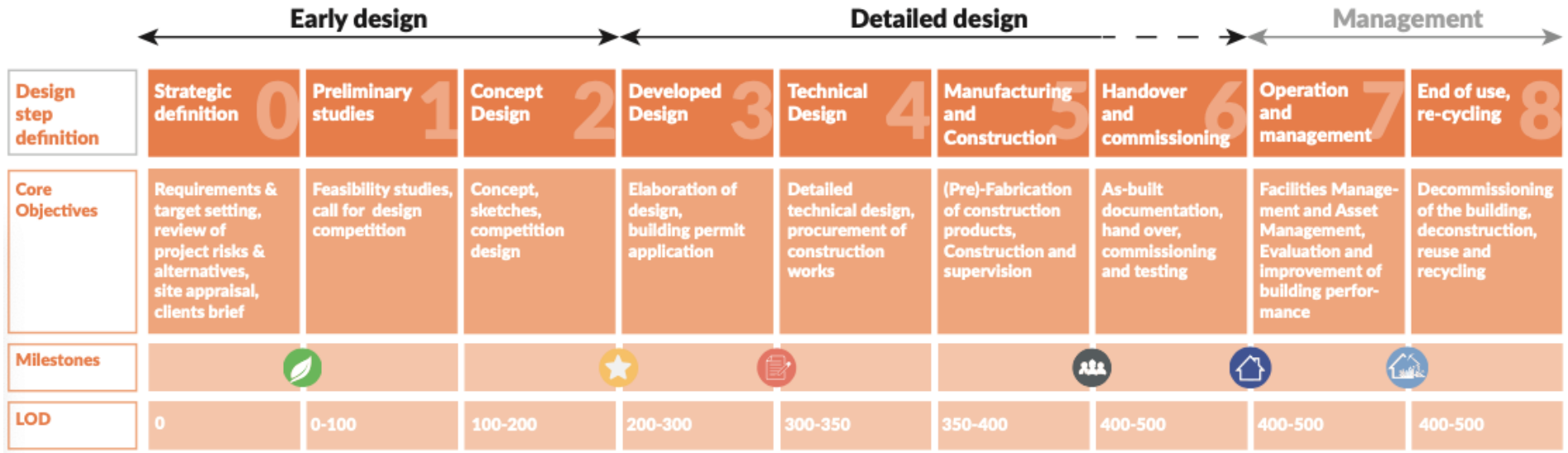
Content

What can be found in the report and background reports?

- The definition of the design steps, the definition of the tasks in each design step and an overview of the relevant milestones for performing LCA;
- An overview of the systematic building decomposition methods and the appropriate levels at each design step;
- An overview of the tools that can be used for LCA and a selection process for choosing the right LCA tool;
- Strategies on how to reduce the design-related uncertainties;
- An overview of the visualisation of the LCA results and which are appropriate in the selected design steps.
- **The purpose is to provide support to the design decisions-makers during the design process.**

Integration into design process

Definiton of the design steps

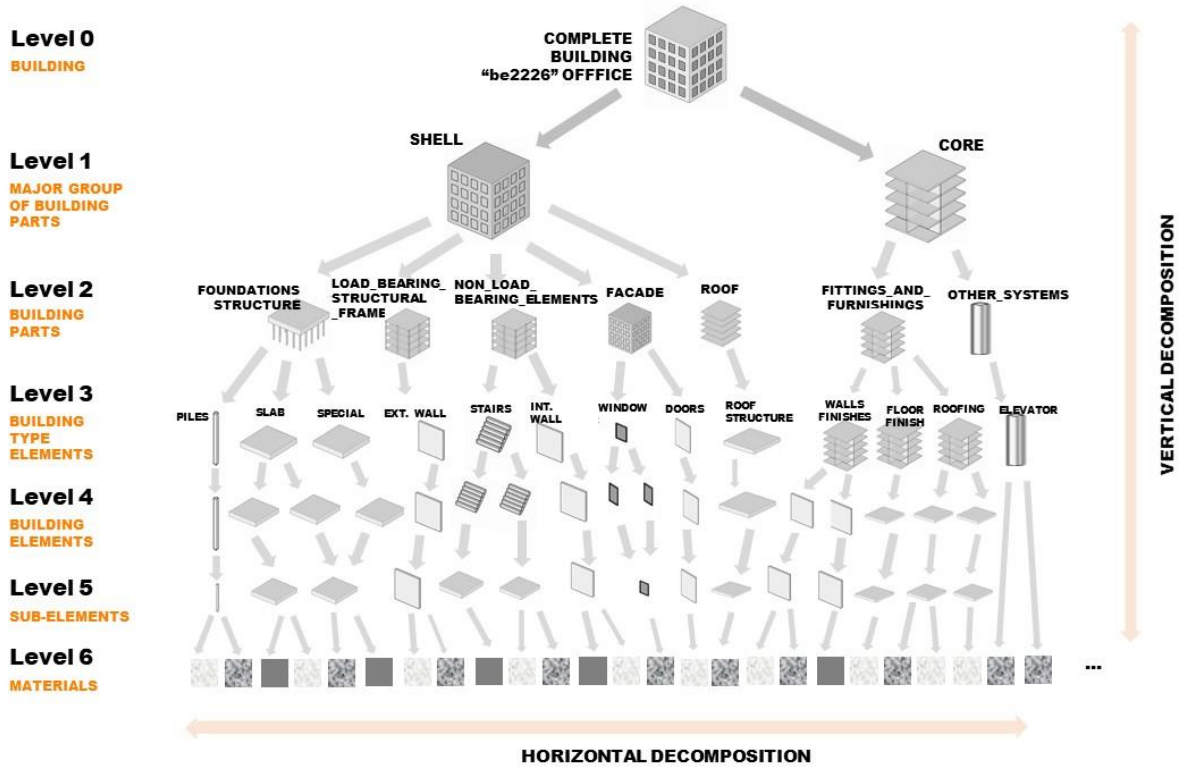


The stakeholders involved into the planning process should be aware what decisions should be made at which design step

The design steps are following RIBA´s recommendations

Integration into design process

Systematic building decomposition



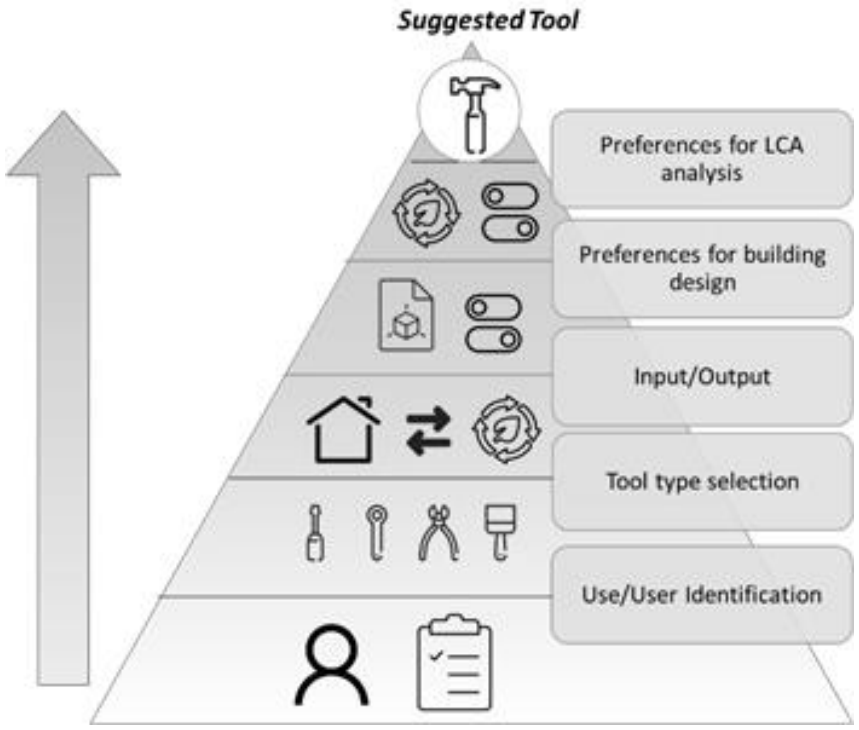
Soust-Verdaguer et al. 2022 (in press)

In principle, an assessment method must be applicable across every design step. Therefore, it is important to disaggregate the building according to:

- existing granularity of the building model
- availability of appropriate data (generic/average versus specific)

Choosing the right tool

Selection procedure for tools



Procedure for tools' identification from toolset

Di Bari et al. 2022

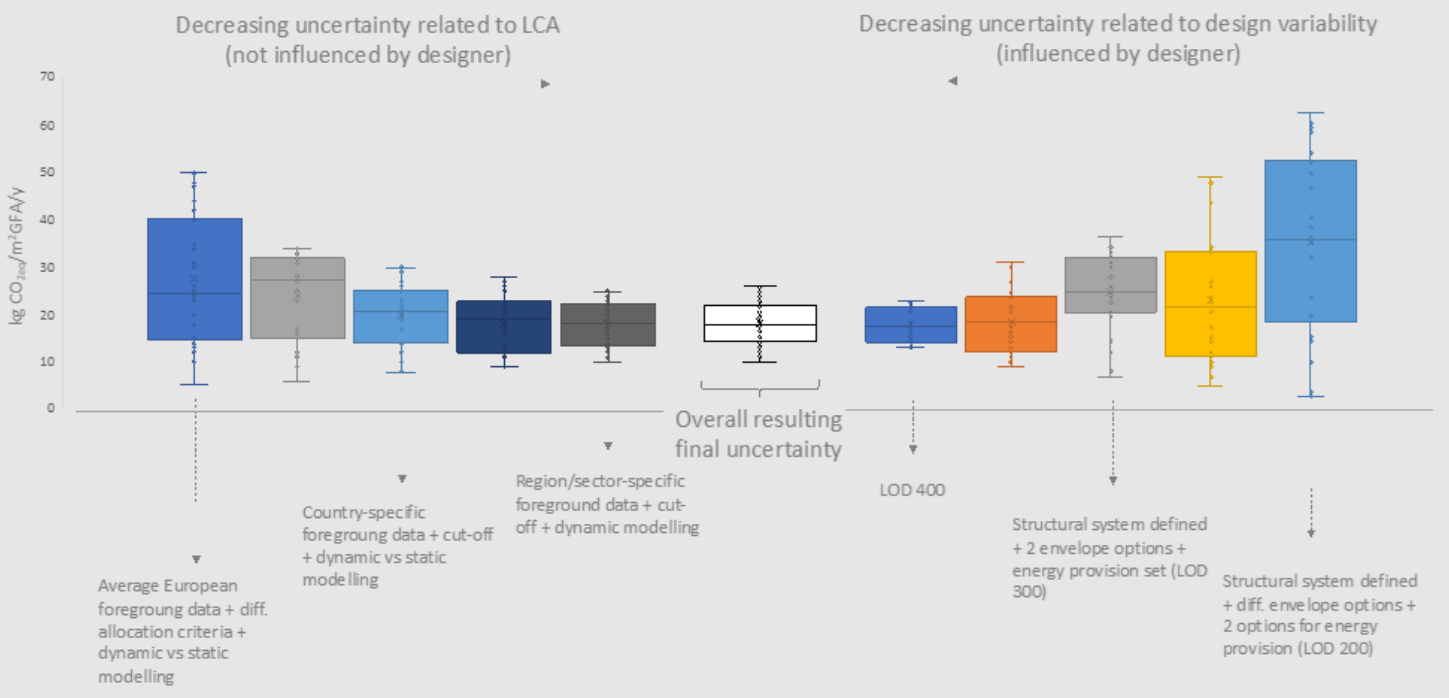
A selection process was developed to choose the most appropriate tool for each design step.

The criteria that was observed:

- usability,
- functionality,
- interoperability and
- compliance of currently available LCA tools

Handling of uncertainties

Typology of sources



Background report Uncertainty 2022

Uncertainties in relation to

- LCA-method in use
- Data quality
- Design variability

The focus in this part were the design-related uncertainties

Handling of uncertainties

Two possible approaches how to handle uncertainties during the design process

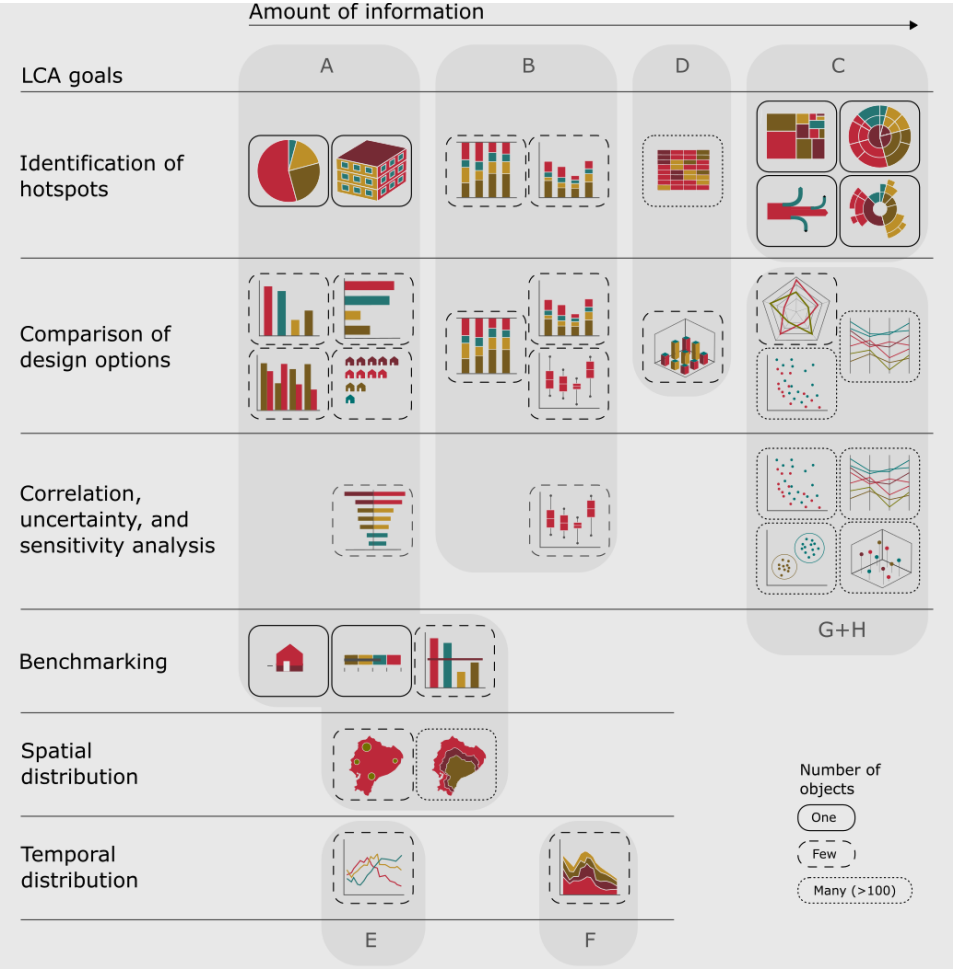
Strategy 1: Project development strategy							
/	/	Definition of the element groups	Definition of the elements (main element material defined) + Definition of the sub-elements uncertainties reported according to the granularity of the data	Definition of the materials as planned-uncertainties reported according to the granularity of the data	Definition of materials as build-uncertainties reduced to the minimum	Definition of materials as build-uncertainties reported reduced to the minimum	Definition of the RSL of materialsuncertainties connected to the RSL scenario
Strategy 2: Optimization							
/	Identification of the most important	Optimization Identifikation of the most important parameters	Optimization of the parameters/elements that were defined as the most relevant	Optimization of the parameters/elements that were defined as the most relevant	No uncertainties reported	No uncertainties reported	No uncertainties reported

Two different strategies are proposed how to reduce the unceratinties during the design process:

- **Project development strategy** (reduce the uncertainty by the evlolution of the available data
- **Optimization strategy** (identification of the most important materials/components and their optimization in the beginning of the design)

Vizualization of the results

Selection procedure of different visualization types



Hollber et al. 2021

A selection process was developed to choose the most appropriate visualization type for the results

A distinction was made based on the LCA goals set for the project

- Hotspots
- Comparison
- Correlation, uncertainty and sensitivity
- Benchmarking
- Spatial distribution
- Temporal distribution

Summary

Key message

- The environmental impacts of the building **should be followed and reduced throughout the design process**.

- A set of guidelines is developed to provide **outlook and recommendations related to the integration** of the LCA into design process and design tools to support the stakeholders involved in the building design process.

- The set of guidelines is **systematically answering questions**:
  - when and for what purpose will the LCA be conducted
  - how to prepare the information about the building
  - which work-flows and tools should be used
  - which visualization and communication to use
  - for whom and for what is the LCA needed

Main results

available from spring 2023

ANNEX 72 EBC

Guidelines for design decision-makers

The Design Decision Table

Target groups

- Clients/Users
- Building designers
- Sustainability assessment and certification experts/Consultants/Auditors
- BIM Managers
- Contractors/Service providers
- Project commissioners/Authority/Policy makers

Main results

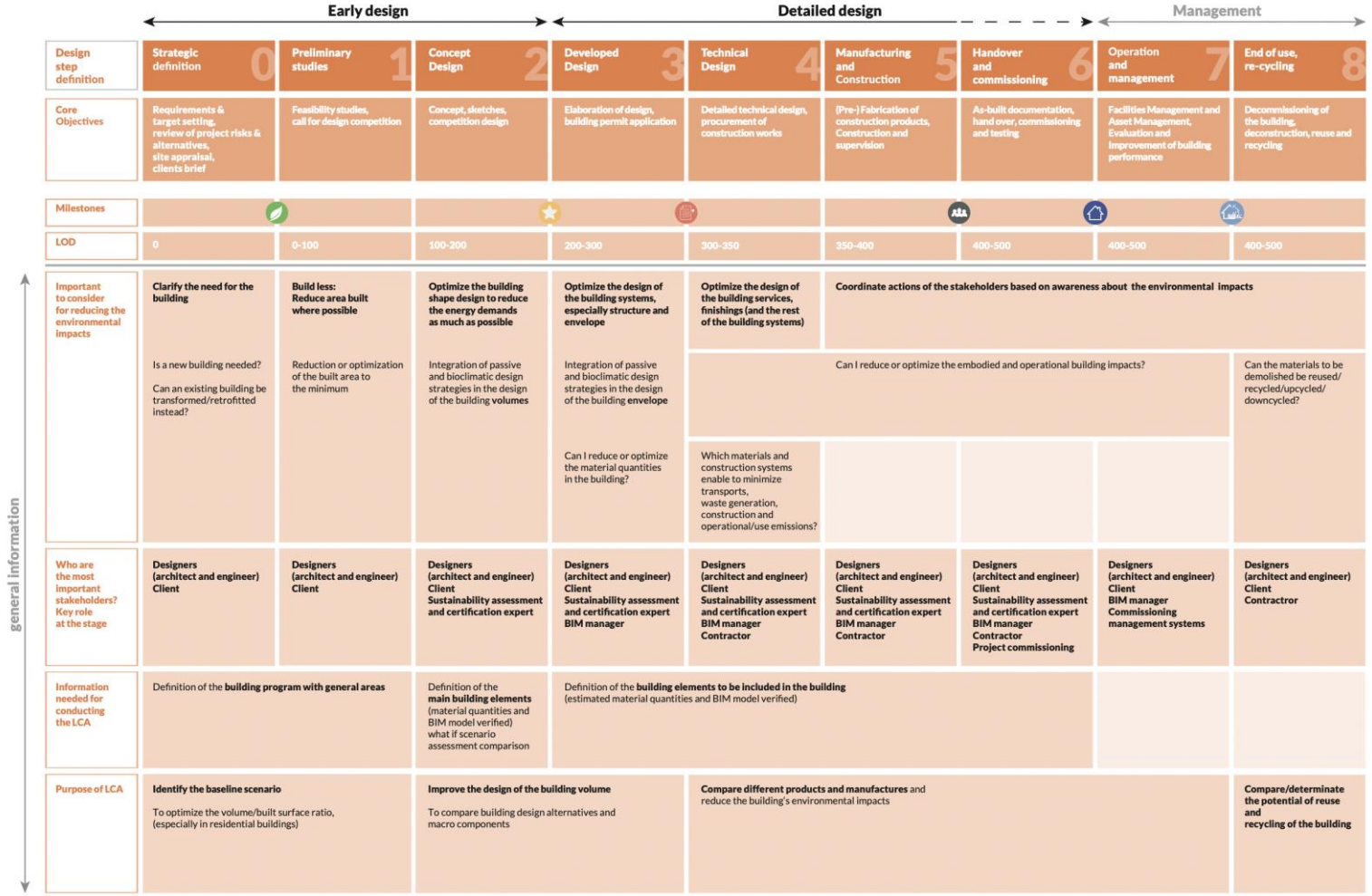
available from spring 2023

ANNEX 72 EBC

The Design Decision Table
Part 1

Design steps

Objectives
Milestones
LODs
Important considerations
Stakeholders
Information needed
Purpose of the LCA



	Early design			Detailed design				Management	
Design step definition	Strategic definition 0	Preliminary studies 1	Concept Design 2	Developed Design 3	Technical Design 4	Manufacturing and Construction 5	Handover and commissioning 6	Operation and management 7	End of use, re-cycling 8
Core Objectives	Requirements & target setting, review of project risks & alternatives, site appraisal, clients brief	Feasibility studies, call for design competition	Concept, sketches, competition design	Elaboration of design, building permit application	Detailed technical design, procurement of construction works	(Pre-) Fabrication of construction products, Construction and supervision	As-built documentation, hand over, commissioning and testing	Facilities Management and Asset Management, Evaluation and Improvement of building performance	Decommissioning of the building, deconstruction, reuse and recycling
Milestones									
LOD	0	0-100	100-200	200-300	300-350	350-400	400-500	400-500	400-500
general information: Important to consider for reducing the environmental impacts	**Clarify the need for the building** Is a new building needed? Can an existing building be transformed/retrofitted instead?	**Build less: Reduce area built where possible** Reduction or optimization of the built area to the minimum	**Optimize the building shape design to reduce the energy demands as much as possible** Integration of passive and bioclimatic design strategies in the design of the building **volumes**	**Optimize the design of the building systems, especially structure and envelope** Integration of passive and bioclimatic design strategies in the design of the building **envelope** Can I reduce or optimize the material quantities in the building?	**Optimize the design of the building services, finishings (and the rest of the building systems)** Which materials and construction systems enable to minimize transports, waste generation, construction and operational/use emissions?	**Coordinate actions of the stakeholders based on awareness about the environmental impacts** Can I reduce or optimize the embodied and operational building impacts?			Can the materials to be demolished be reused/ recycled/upcycled/ downcycled?
Who are the most important stakeholders? Key role at the stage	**Designers (architect and engineer) Client**	**Designers (architect and engineer) Client**	**Designers (architect and engineer) Client Sustainability assessment and certification expert**	**Designers (architect and engineer) Client Sustainability assessment and certification expert BIM manager**	**Designers (architect and engineer) Client Sustainability assessment and certification expert BIM manager Contractor**	**Designers (architect and engineer) Client Sustainability assessment and certification expert BIM manager Contractor**	**Designers (architect and engineer) Client Sustainability assessment and certification expert BIM manager Contractor Project commissioning**	**Designers (architect and engineer) Client BIM manager Commissioning management systems**	**Designers (architect and engineer) Client Contractror**
Information needed for conducting the LCA	Definition of the **building program with general areas**		Definition of the **main building elements** (material quantities and BIM model verified) what if scenario assessment comparison	Definition of the **building elements to be included in the building** (estimated material quantities and BIM model verified)					
Purpose of LCA	**Identify the baseline scenario** To optimize the volume/built surface ratio, (especially in residential buildings)		**Improve the design of the building volume** To compare building design alternatives and macro components	**Compare different products and manufactures** and reduce the building's environmental impacts					**Compare/determinate the potential of reuse and recycling of the building**

Main results

available from spring 2023

ANNEX 72 EBC

The Design Decision Table
Part 2

Task of the design stages
Decomposition levels to be used
Tools (BIM)
Uncertainties
Visualisation types to be used

related to background

Task of the design stage TASK 1 Design steps and project phases	Setting and identifying the target impacts based on the building program, typology, country, etc.	Verify the surfaces and building geometry with the target estimated impacts. Re-define or adjust the design.	Verify the systems and building elements material estimations with the target or benchmarks impacts. Re-define or adjust the design.	Verify the material estimations (including technical equipment, installations) with the traget or benchmarks impacts. Re-define or adjust the design.	Labeling or certification of the building impacts befor/after construction, considering the real materials and process of the building.	Tracking the certified impacts values along the building life cycles in the maintenance, repair, refurbishment and substitution stages.	Identify potential re-use or valorization of the building elements and materials. Consider the building as a material bank to the next generations.
Which level of decomposition to should be used? TASK 2 Systematic building decomposition in LCA	**Floor areas (with different functions)**		**Elements/Components**	**Materials** **Generic material data** **Product specifi- material data** →			
How to reduce the design related uncertainties? TASK 3 Uncertainties	**Strategy 1: Project development strategy** /	/	Definition of the element groups	Definition of the elements (main element material defined) + Definition of the sub-elements uncertainties reported according to the granularity of the data	Definition of the materials as planned-uncertainties reported according to the granularity of the data	Definition of materials as build-uncertainties reduced to the minimum	Definition of materials as build-uncertainties reported reduced to the minimum	Definition of the RSL of materialsuncertainties connected to the RSL scenario
	Strategy 2: Optimization /	Identification of the most important	Optimization Identifikation of the most important parameters	Optimization of the parameters/elements that were defined as the most relevant	Optimization of the parameters/elements that were defined as the most relevant	No uncertainties reported	No uncertainties reported	No uncertainties reported
How can BIM help/improve the LCA during the deign process? TASK 4 BIM-LCA tools	Enables to obtain a systematic quantity take-off from the BIM model. Allows to atomatically update of the element extraction, if the design is modified.		Enables to obtain a systematic component quantity take-off for the BIM model. Allows to atomatically update of the component quantities extraction, if the design is modified.	Enables to obtain a systematic material quantity take-off from the BIM model. Allows to atomatically update of the material extraction, if the design is modified.	Enables to obtain a systematic material quantity take-off from the as built BIM model.			
	Allows to use the same BIM model for different purpose that can faciliate the LCA application during the design process, such as operational energy calculation, optimization, etc.			Allows to use the same BIM model for different purpose that can faciliate the LCA application during the detail design process, such as technical equipments and installations design, building management, etc.	Allows to automatically update of the material extraction, if the design is modified before the construction. Allows to use the same BIM model for different purpose that can facilitate the LCA application during. It can enable the data exchange with the digital permit, digital twins, etc.	Allows to automatically update of the material extraction, if the design is modified during the use phase. Allows to use the same BIM model for different purpose that can facilitate the LCA application during the operational phases (repair, refurbishment, replacement). It can enable the data exchange with the digital logbook, building and material passport, energy performance certifcate, digital twins, etc.	
What is the purpose of the visualization and which types should be used? TASK 6 Visualization in LCA		Purpose: **Identification of hotspots** Comparison of design options		Purpose: **Comparison of design options** Correlation, uncertainties and sensitivity analysis		Purpose: **Temporal distribution** Spatial distribution	

Thank you!

All the reports and background reports and the Design decision table will be available from spring 2023