ANNEX 72 EBC

Energy in Buildings and Communities Programme

IEA EBC Annex 72

ASSESSING LIFE CYCLE RELATED ENVIRONMENTAL IMPACTS CAUSED BY BUILDINGS

Rolf Frischknecht
Operating Agent, Switzerland
Thomas Lützkendorf, ST1 Lead, Germany
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Tajda Obrecht, Austria

9.3.2023, Vienna

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Website - annex72.iea-ebc.org

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

Investment decisions for buildings made today largely determine their environmental impacts over many future decades due to their long lifetimes. Furthermore, such decisions involve a trade-off between additional investments today and potential savings during use and at end of life - in terms of economic costs, primary energy demand, greenhouse gas emissions and other environmental impacts. Since the economic system does not fully account for external environmental effects, environmental resources are used inefficiently. Life cycle assessment (LCA) is suited to complement economic information on buildings with information on their environmental impacts. LCA helps to take measures and action to increase the resource efficiency of buildings and construction.

ANNEX INFO & CONTACT

Status: Ongoing (2016 - 2022)

OPERATING AGENT

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Short History

Annex 31: Energy Related Environmental Impact of Buildings

Annex 57: Evaluation of Embodied Energy and CO2 Equivalent Emissions for Building Construction

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

EMBODIED ENERGY

↓

EMBODIED EMISSIONS

↓

OVERALL EMISSIONS IN WHOLE LIFE CYCLE

Participants (22+3)

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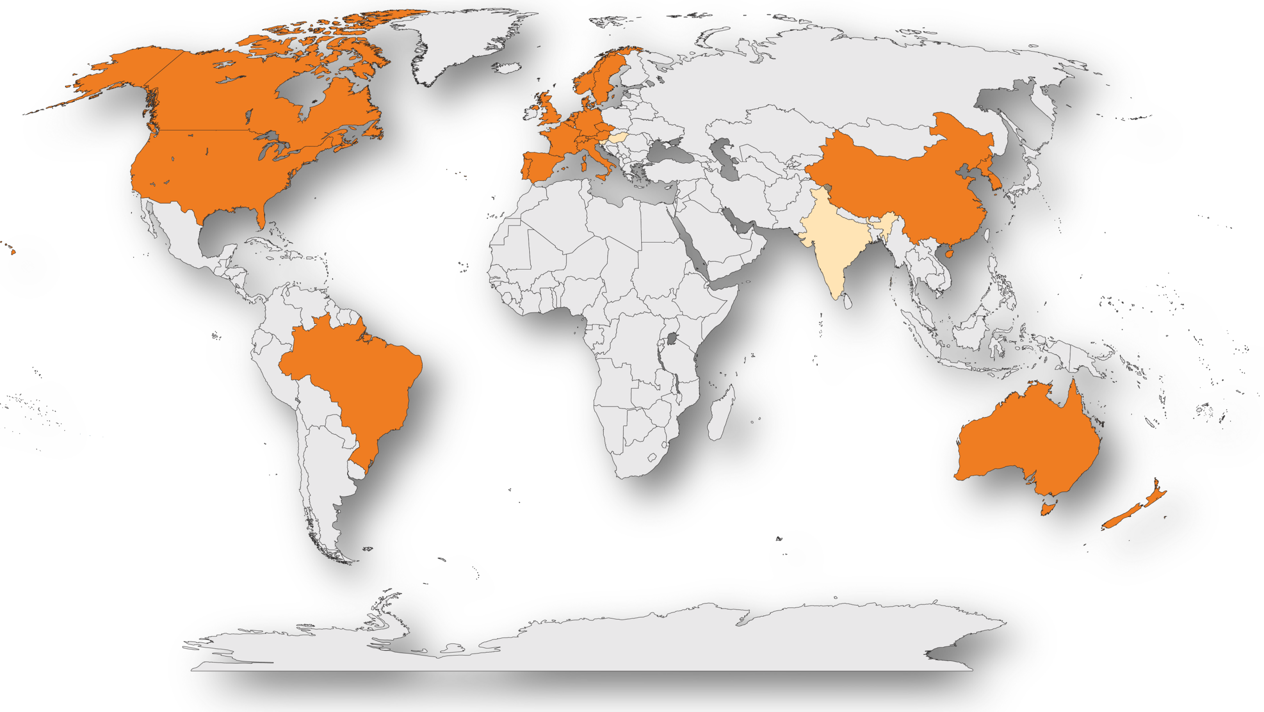
- Australia
- Austria
- Belgium
- Brazil
- Canada
- China
- Czech Republic
- Denmark
- France
- Germany
- Hong Kong
- Italy
- Korea
- Netherlands
- New Zealand
- Norway
- Portugal
- Spain
- Sweden
- Switzerland
- United Kingdom
- USA
- Hungary (o)
- India (o)
- Slovenia (o)



Assessing Life Cycle Related Environmental Impacts Caused by Buildings

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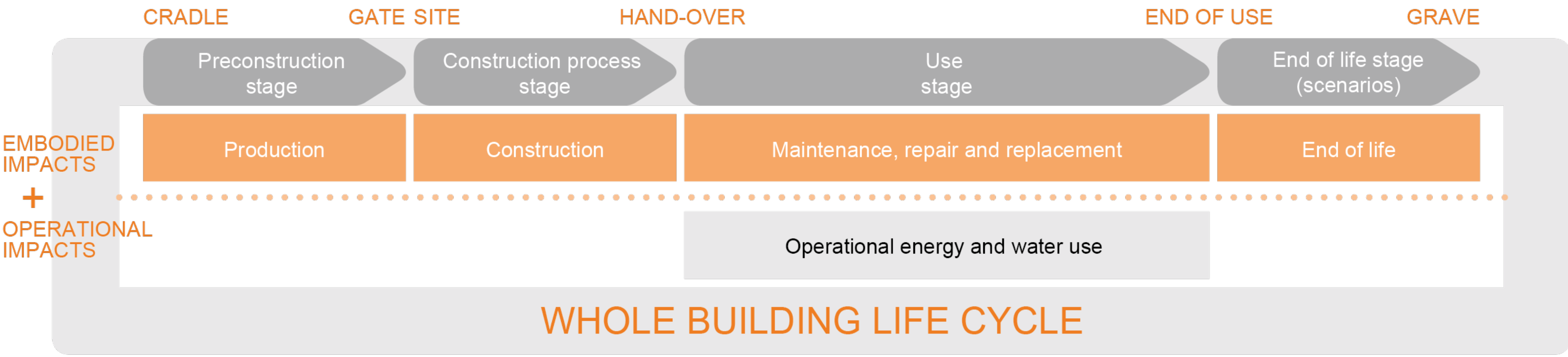

Net Zero

Global Carbon Budget

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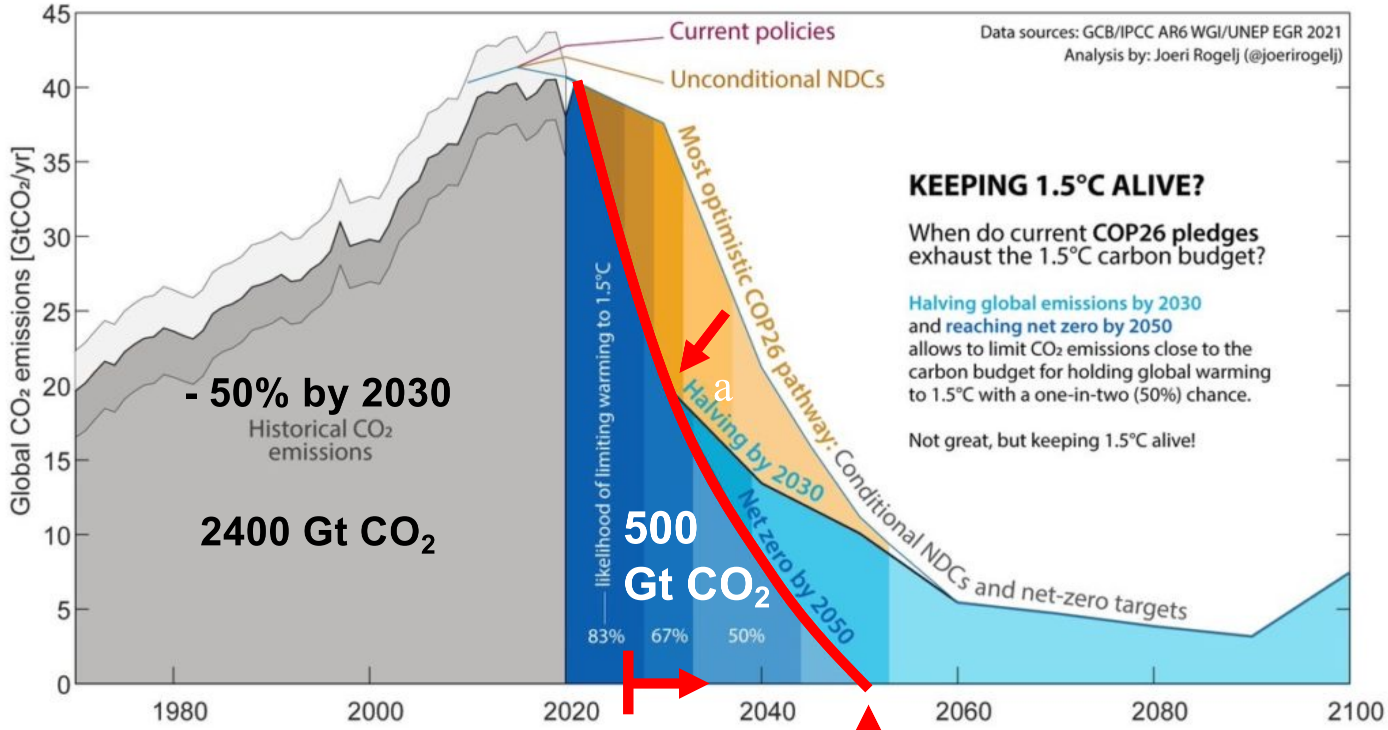

As of 2020 only 500 Gt CO_2 available to meet 1,5°C (50% probability)

IPCC AR6,Table SPM.2

- Climate neutrality should be achieved before 2040

Introduction of binding legal requirements from 2025 on

Budget exhausted before ~ 2050

Technology and innovation pathways for zero-carbon-ready buildings by 2030

A strategic vision from the IEA Technology Collaboration Programmes

Austrian IEA TCP Day, "Mission Net Zero"- Vienna, 27th September 2022

Ezilda Costanzo, IEA EUWP Building vice-chair (ENEA, IT)
Chiara Delmastro, International Energy Agency (IEA)

Operational Energy Related CO_2 Emissions of Buildings

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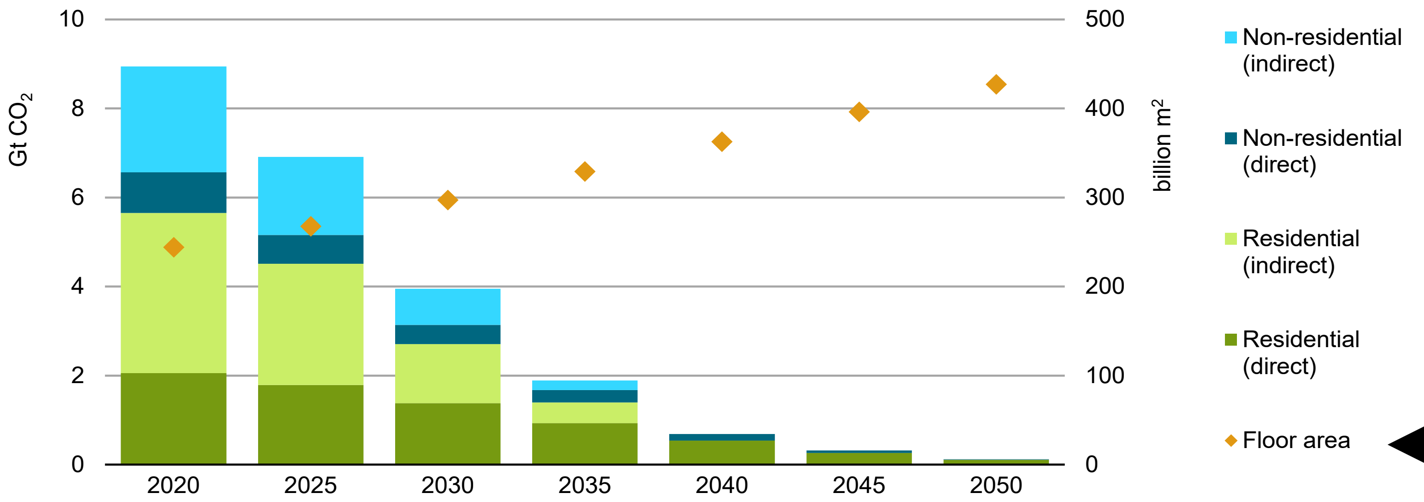
Short terms actions are urgently needed to achieve 2050 goals

Global buildings sector CO_2 emissions and floor area in the NZE by 2050 Scenario



Increasing floor area

Decarbonising buildings requires drastic and immediate policy action to stimulate behaviour and technology shifts

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Assessing Operational and Embodied Emissions – Current Trends

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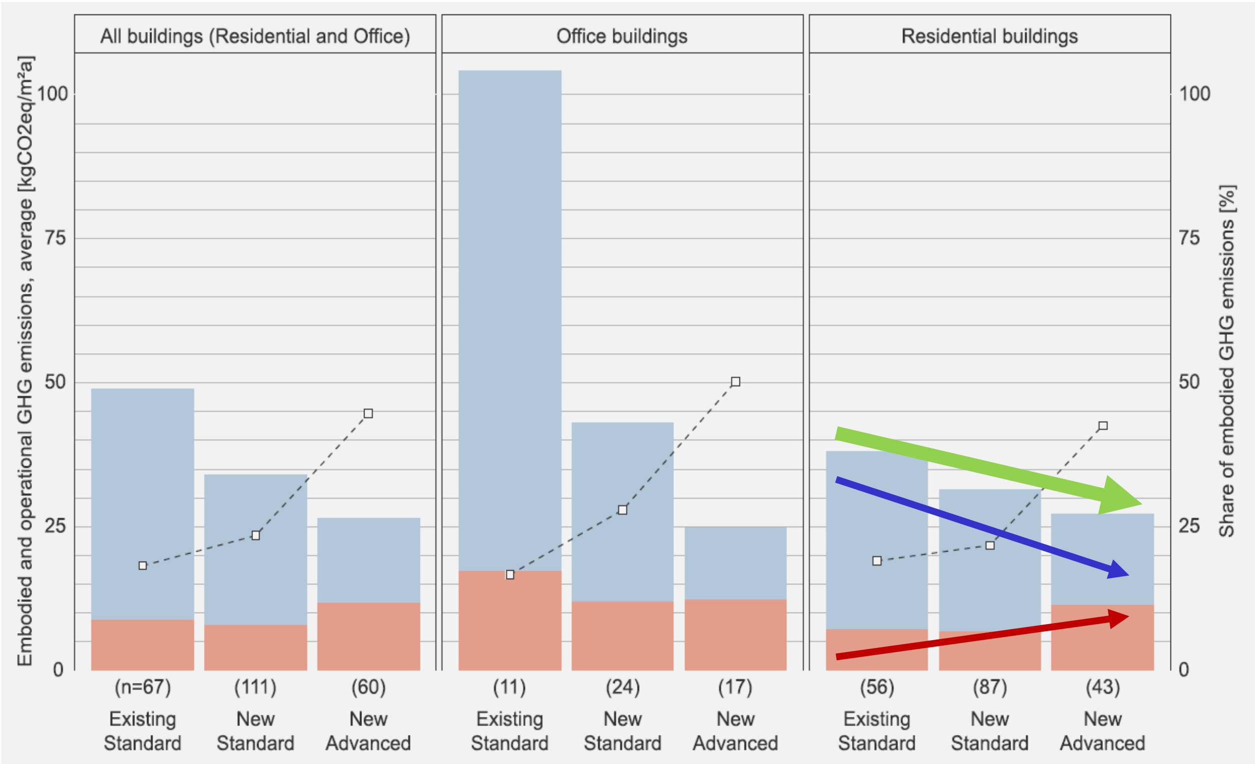

- There is a downward trend in operational emissions relating to an improved energy performance and increasing use of renewable energy.
- The relative and absolute values of embodied impacts (here embodied GHG emissions) increase.
- The consideration of the entire life cycle, the limitation of the upfront/initial emissions, as well as the development of overall goals and guidance values for operational and embodied GHG emissions are necessary.

Martin Röck, Marcella Ruschi Mendes Saade, Maria Balouktsi, Freja Nygaard Rasmussen, Harpa Birgisdottir, Rolf Frischknecht, Guillaume Habert, Thomas Lützkendorf, Alexander Passer, 2019

Current Discussion on International Level

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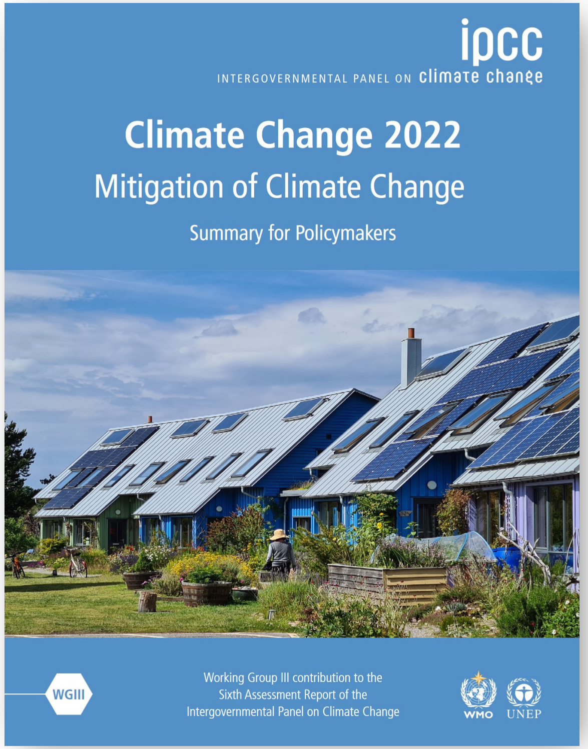

IPCC - Climate Change 2022 – Mitigation of Climate Change (AR6 WG3): https://www.ipcc.ch/report/ar6/wg3/

Final Government Distribution Chapter 9 IPCC AR6 WGIII

9.4.2.2 Embodied emissions

Embodied emissions from production of materials are an important component of building sector emissions, and their share is likely to increase as emissions from building energy demand decrease (Röck et al. 2020). Embodied emissions trajectories can be lowered by limiting the amount of new floor area required (Berrill and Hertwich 2021; Fishman et al. 2021), and reducing the quantity and GHG intensity of materials through material efficiency measures such as lightweighting and improved building design, material substitution to lower-carbon alternatives, higher fabrication yields and scrap recovery during material production, and re-use or lifetime extension of building components (Allwood et al. 2011; Pamenter and Myers 2021; Churkina et al. 2020; Heeren et al. 2015b; Pauliuk et al. 2021; Hertwich et al. 2019). Reducing the GHG intensity of energy supply to material production activities also has a large influence on reducing overall embodied emissions. Figure 9.10 shows projections of embodied emissions to 2050 from residential buildings in a baseline scenario (SSP2 Baseline) and a scenario incorporating multiple material efficiency measures and a much faster decarbonization of energy supply (LED and 2°C policy) (Pauliuk et al. 2021). Embodied emissions are projected to be 32% lower in 2050 than 2020 in a baseline scenario, primarily due to a lower growth rate of building floor area per population. This is because the global population growth rate slows over the coming decades, leading to less demand for new floor area relative to total population. Further baseline reductions in embodied emissions between 2020 and 2050 derive from improvements in material production and a gradual decline in GHG intensity of energy supply. In a LED + 2°C policy scenario, 2050 embodied emissions are 86% lower than the Baseline. This reduction of 2050 emissions comes from contributions of comparable magnitude from three sources; slower floor area growth leading to less floor area of new construction per capita (sufficiency), reductions in the mass of materials required for each unit of newly built floor area (material efficiency), and reduction in the GHG intensity of material production, from material substitution to lower carbon materials, and faster transition of energy supply.

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How does a net-zero GHG emissions building looks like?

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Subtask 1: ExLife Cycle Model for Buildings

Adapted from EN 15643 and current draft of EN 15978-1

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Embodied impacts

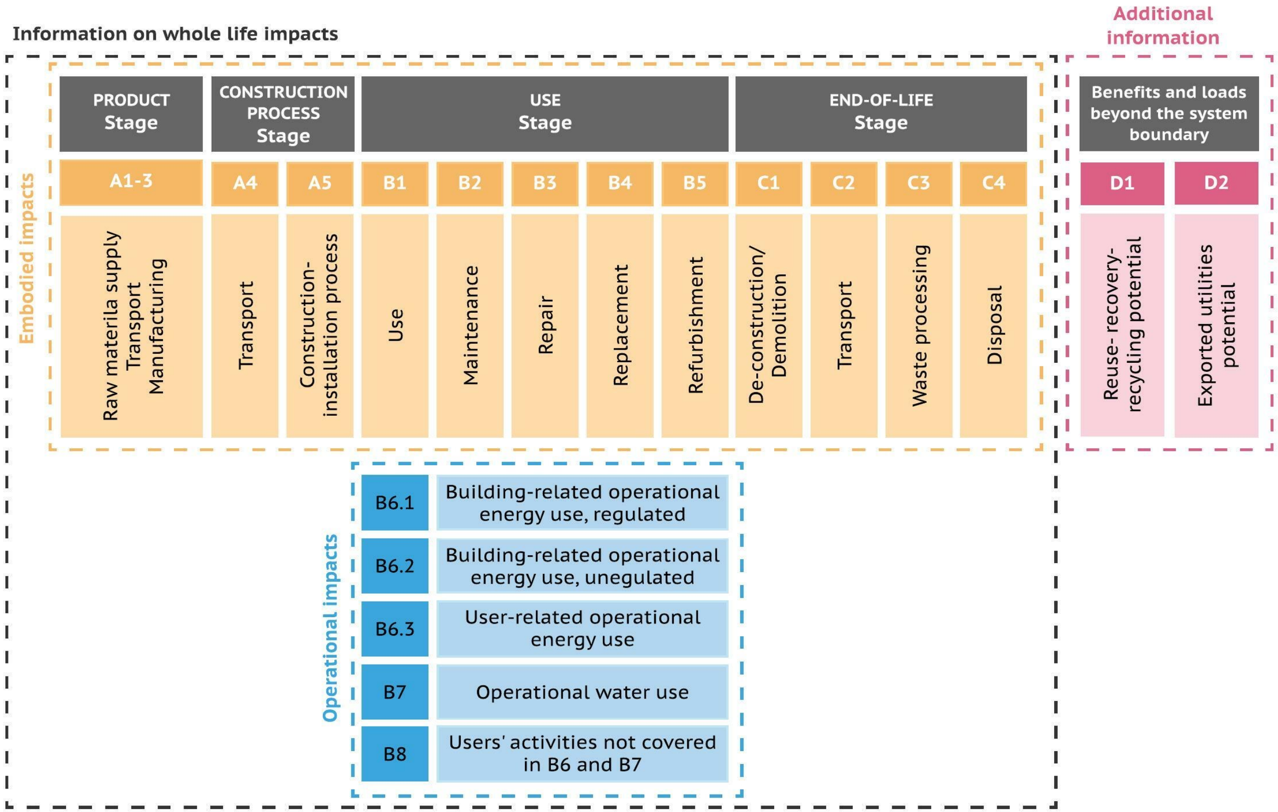
- Upfront
- Recurring
- EoL

Operational impacts

- Regulated
- Unregulated
- User related
- *Non-energy related*

Additional information

- Recycling potential
- Potentially avoided impacts from exported energy



Subtask 1:

How to reach net zero GHG emission buildings

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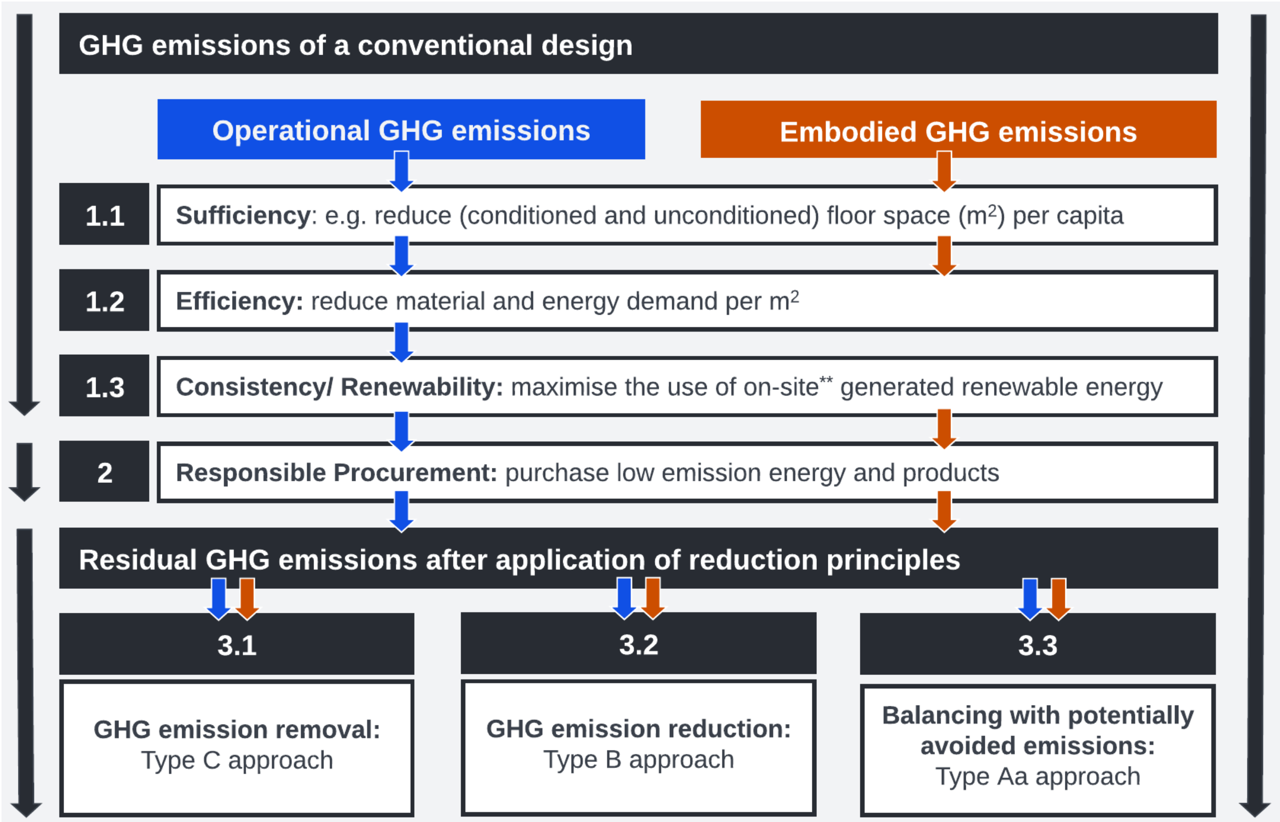
Recommended route to (net) zero GHG emission buildings

(1) Reduce via low carbon design strategies

(2) Reduce via low carbon purchasing strategies

(3) Offset and/ or balance



Subtask 1: Absolute versus Net Zero

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Options to define and achieve (net) zero GHG emission buildings

Net Zero Emission Approaches						Zero emission
Net balance (Aa)	**Net balance (Ab)**	**Technical reduction (Ba)**	**Technical reduction (Bb)**	**Technical removal (Ca)**	**Technical removal (Cb)**	**Absolute Zero**
potentially avoided emissions	**allocation**	**indirect**	**direct**	**potentially reversible**	**stable**	**-**
Accounting for the potential benefits caused by exported energy produced on-site	Attributes the pro rata share of GHG emissions caused by on-site energy production to the exported energy	Investment in projects, which lead to potential CO_2/ GHG emission reductions elsewhere such as investments in solar or wind power plants*	Investment in CO_2/GHG emission reduction projects such as CCS equipment in coal power plants*	Investment in projects, which remove CO_2 from the atmosphere, but with potential reversibility, such as biological fixation*	Investment in projects, which remove CO_2 from the atmosphere, such as BECCS or DACCS*	Use of construction materials/operational energy with zero GHG emissions (including supply chain emissions)

*contribution to initial financing and implement., or purchase of corresponding emission certificates

\- ⟶ +

Level of Ambition

Lützkendorf, T. and Frischknecht, R., 2020. (Net-) zero-emission buildings: a typology of terms and definitions. *Buildings and Cities*, 1(1), pp.662–675. DOI: http://doi.org/10.5334/bc.66

Subtask 1: Methodology

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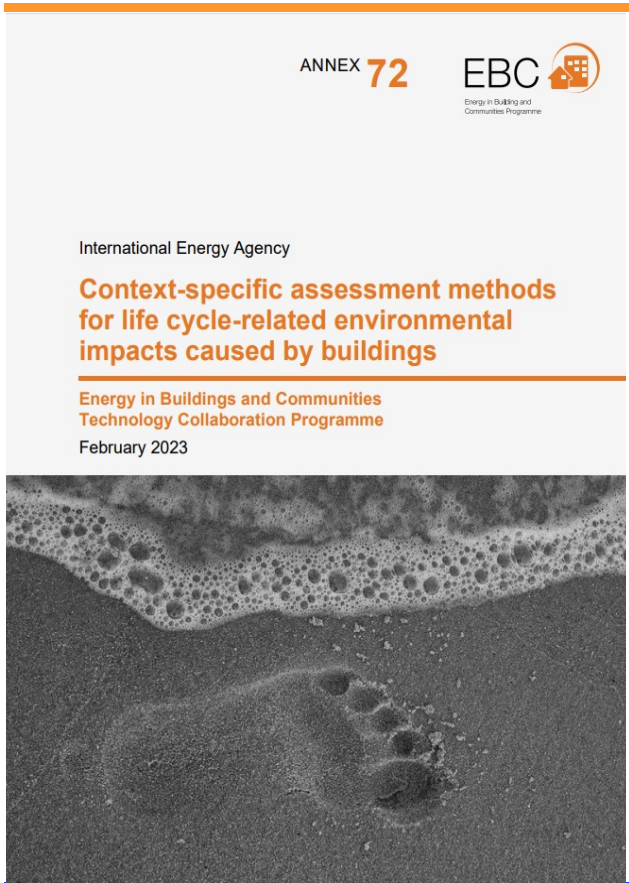

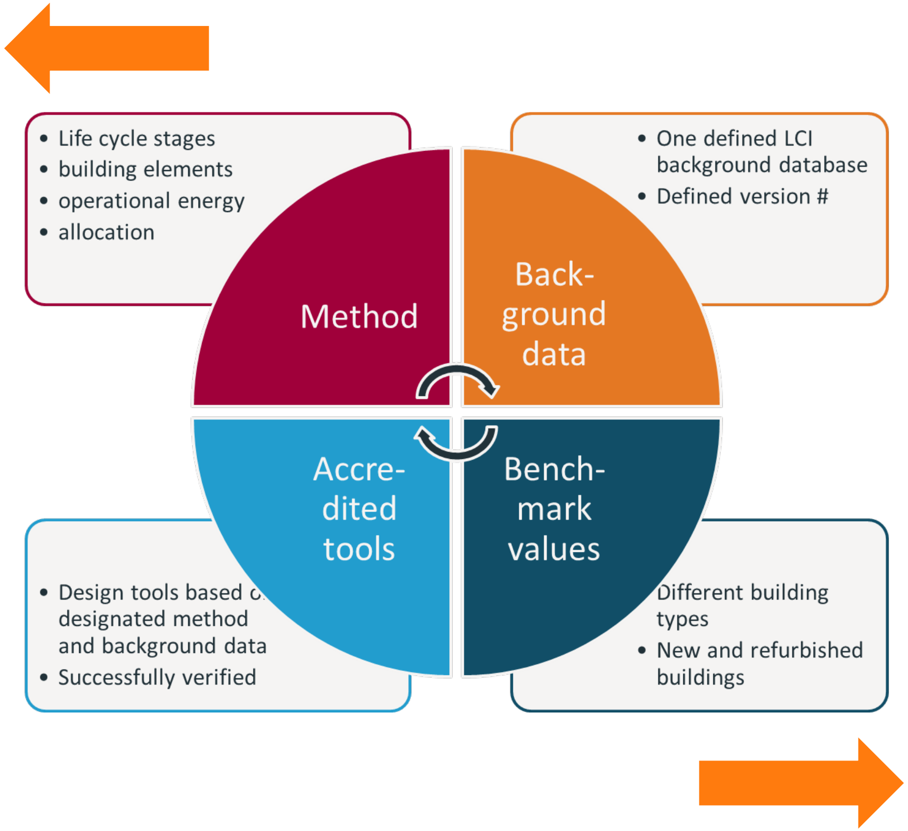

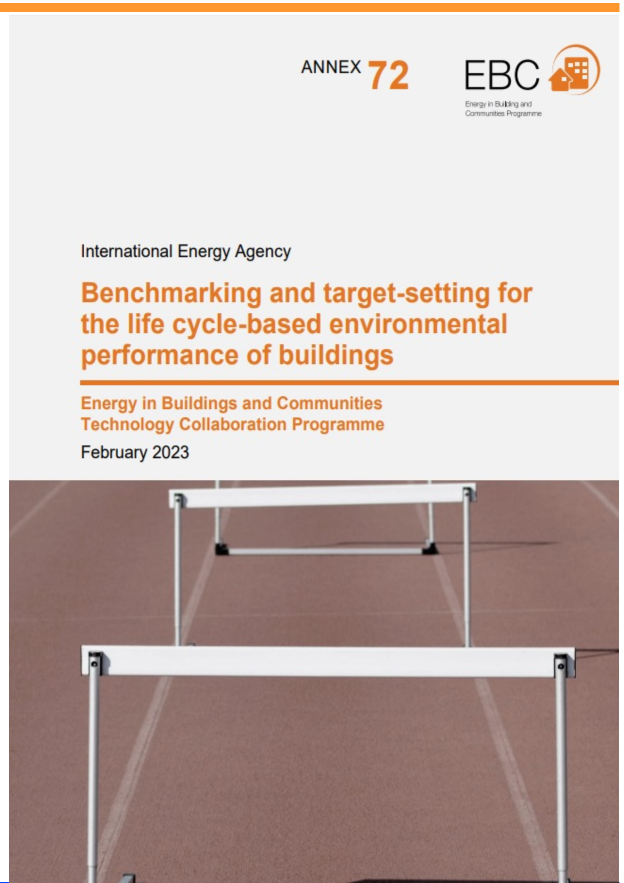

Subtask 1: Österr. Beitrag

LCA Survey

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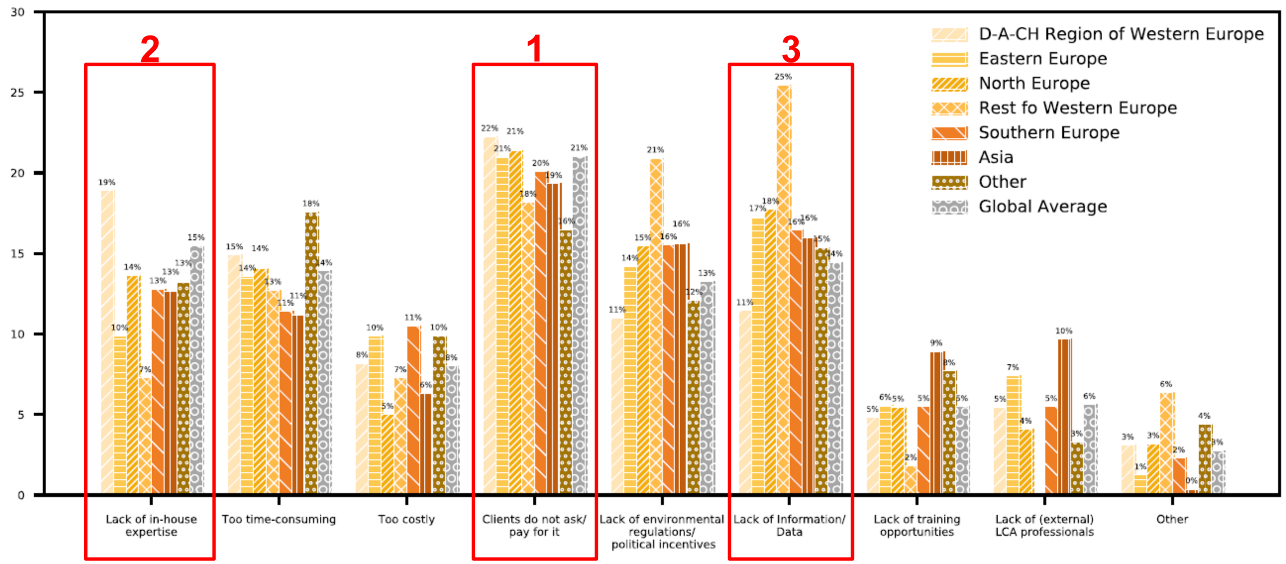
- Survey (D-A-CH und Worldwide)
- Online survey launched in 23 countries
- Number of respondents: 1166 (Europe: 956)
- Survey period: 2018/2019

➢ What is the current state of **knowledge** and practical **application of the LCA-method** among designers?
➢ What are the **barriers**?
➢ What can be recommended for action?



BEYOND2020 NOV 2-4
WORLD SUSTAINABLE BUILT ENVIRONMENT ONLINE CONFERENCE

Balouktsi, M., Lützkendorf, T., Röck, M., Passer, A., Reisinger, T., Frischknecht, R., 2020. Survey results on acceptance and use of Life Cycle Assessment among designers in world regions: IEA EBC Annex 72. IOP Conf. Ser. Earth Environ. Sci. 588, 032023. https://doi.org/10.1088/1755-1315/588/3/032023

Subtask 1: Österr. Beitrag

Biogenic Carbon

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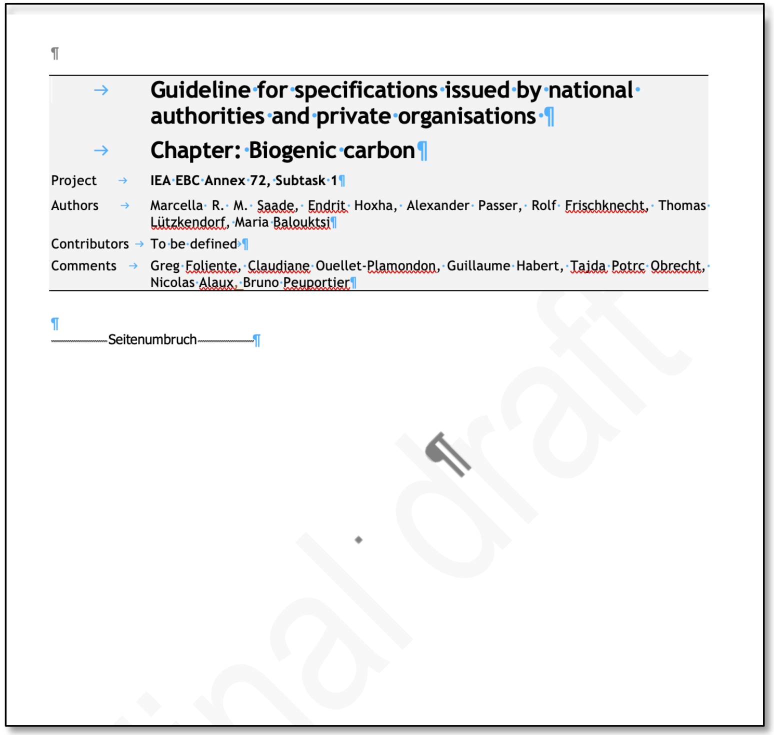


Guideline for specifications issued by national authorities and private organisations

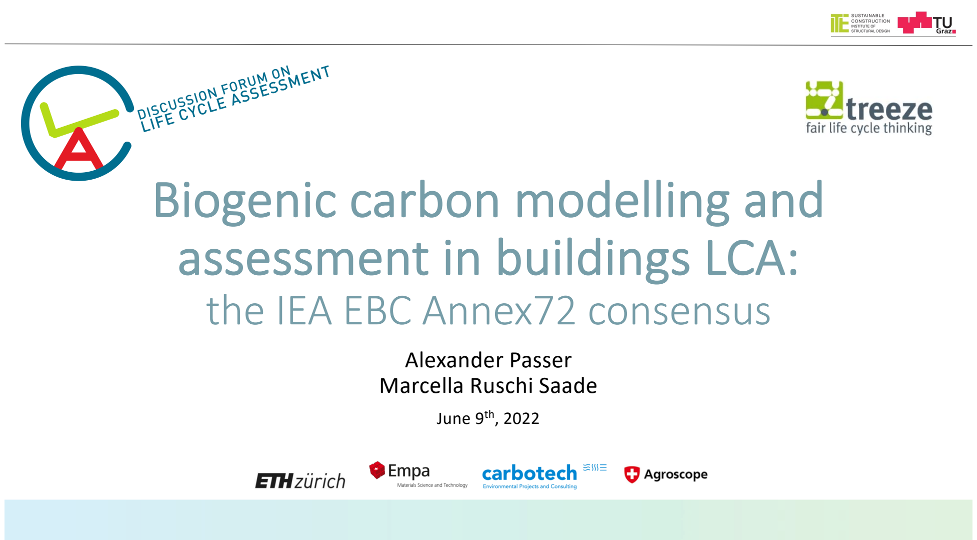
Chapter: Biogenic carbon

Project	IEA EBC Annex 72, Subtask 1
Authors	Marcella R. M. Saade, Endrit Hoxha, Alexander Passer, Rolf Frischknecht, Thomas Lützkendorf, Maria Balouktsi
Contributors	To be defined
Comments	Greg Foliente, Claudiane Ouellet-Plamondon, Guillaume Habert, Tajda Potrc Obrecht, Nicolas Alaux, Bruno Peuportier

Seitenumbruch

final draft

80th LCA Forum - Biogenic carbon and climate change mitigation: silver bullet or flash in the pan?



https://video.ethz.ch/events/lca/2022/spring/80th.html

Subtask 2: Design Tools

Lead AT: Alexander Passer

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 with the **design decision table**

Subtask 2: Integration into Design Process

Definition if the Design Steps

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	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

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

- The design steps are following RIBA´s recommendations.

Subtask 2: Integration into Design Process

Systematic Building Decomposition

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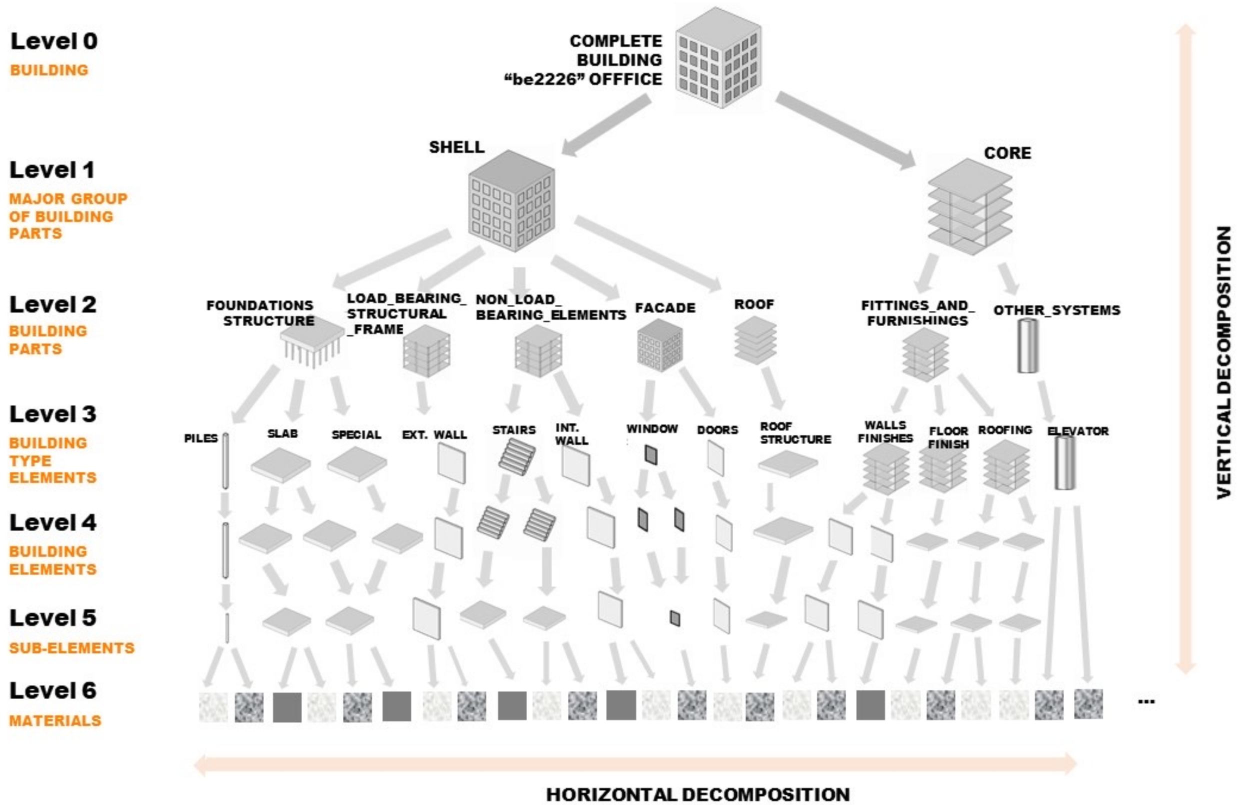
In principle, an assessment method must be applicable across every design step. Therefore, it is important to disaggregate the building according to:

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



Soust-Verdaguer, B., et al., 2023. Using systematic building decomposition for implementing LCA: The results of a comparative analysis as part of IEA EBC Annex 72. J. Clean. Prod. 384, 135422. https://doi.org/10.1016/j.jclepro.2022.135422

Subtask 2: Choosing the Right Tool

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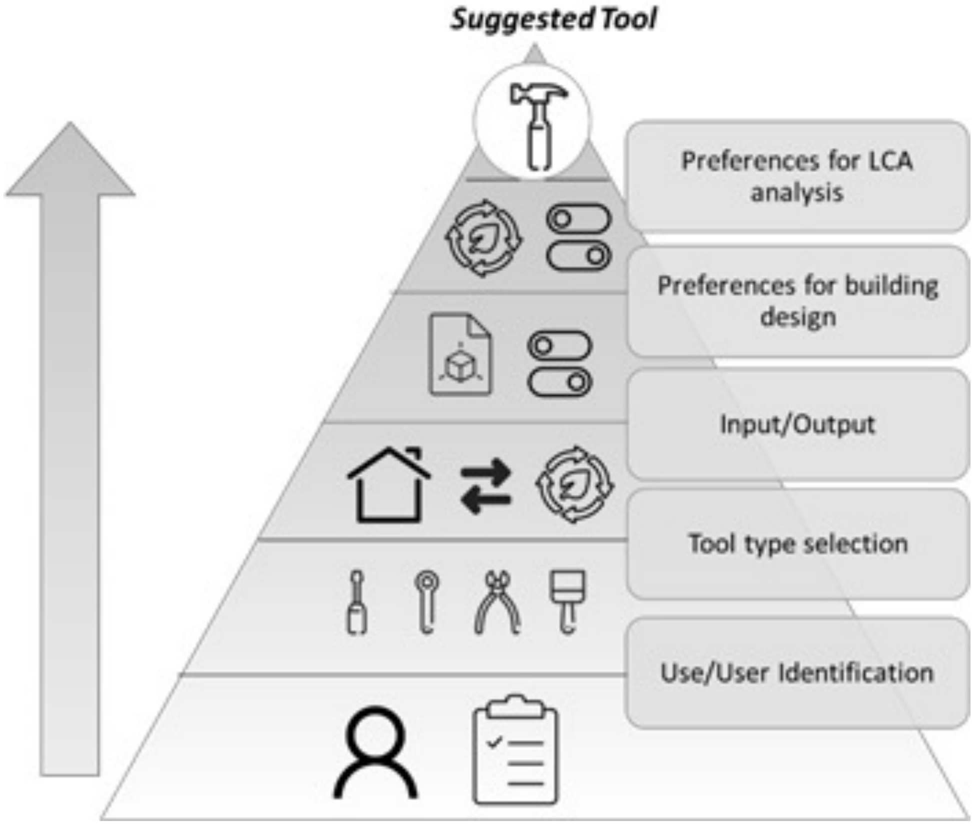
Selection Procedure for Tools

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



Procedure for tools' identification from toolset, Di Bari et al. 2022

Subtask 2: Handling of Uncertainties

Typology of sources

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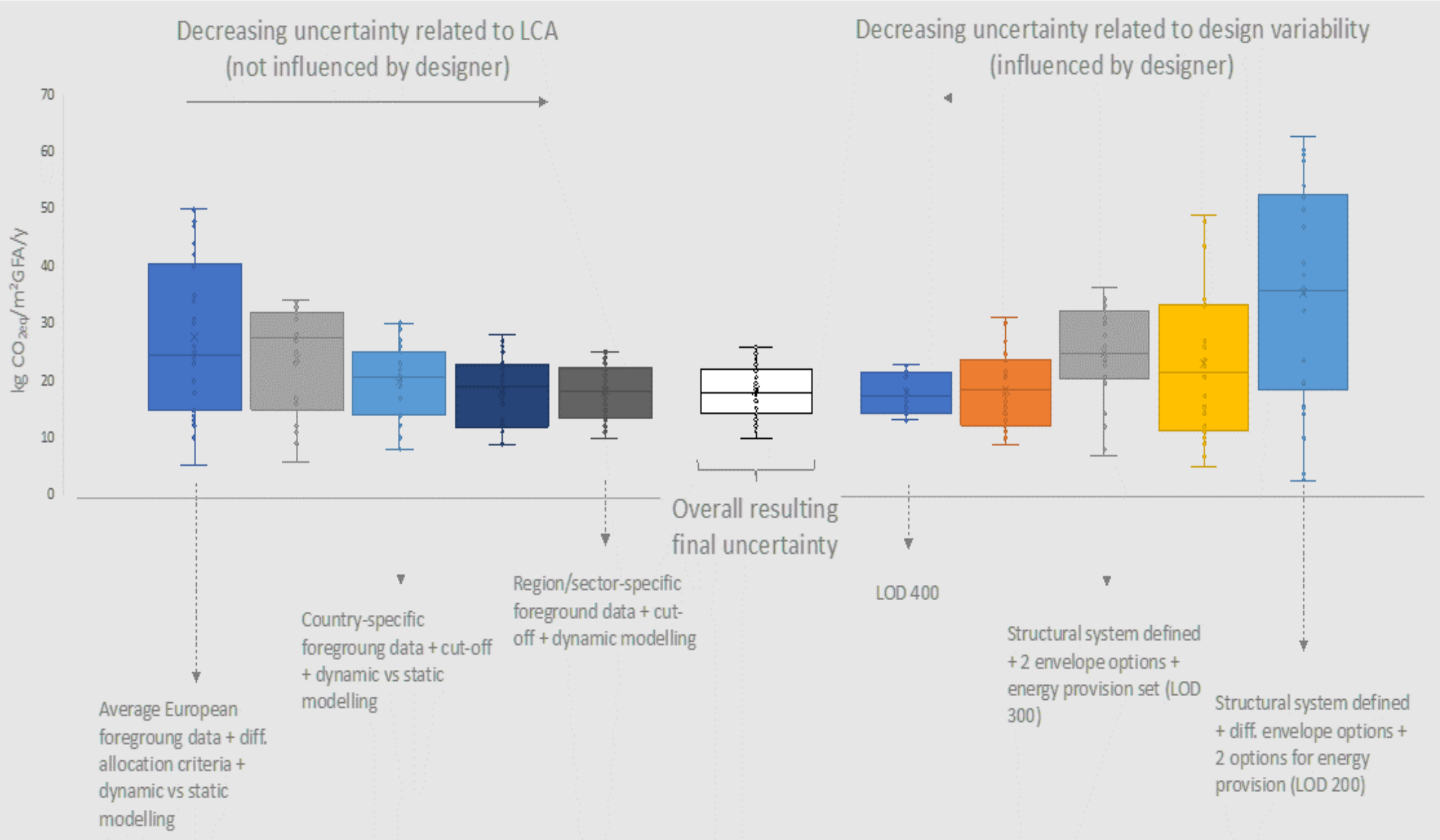
Uncertainties in relation to
- LCA-method in use
- Data quality
- Design variability

Further research is needed to capture, assess and communicate the degree of uncertainty of an assessment result.



Subtask 2: Handling of Uncertainties

Two Possible Approaches for the Design Process

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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)

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

Subtask 2: Visualization of the Results

Selection Procedure of different Visualization Types

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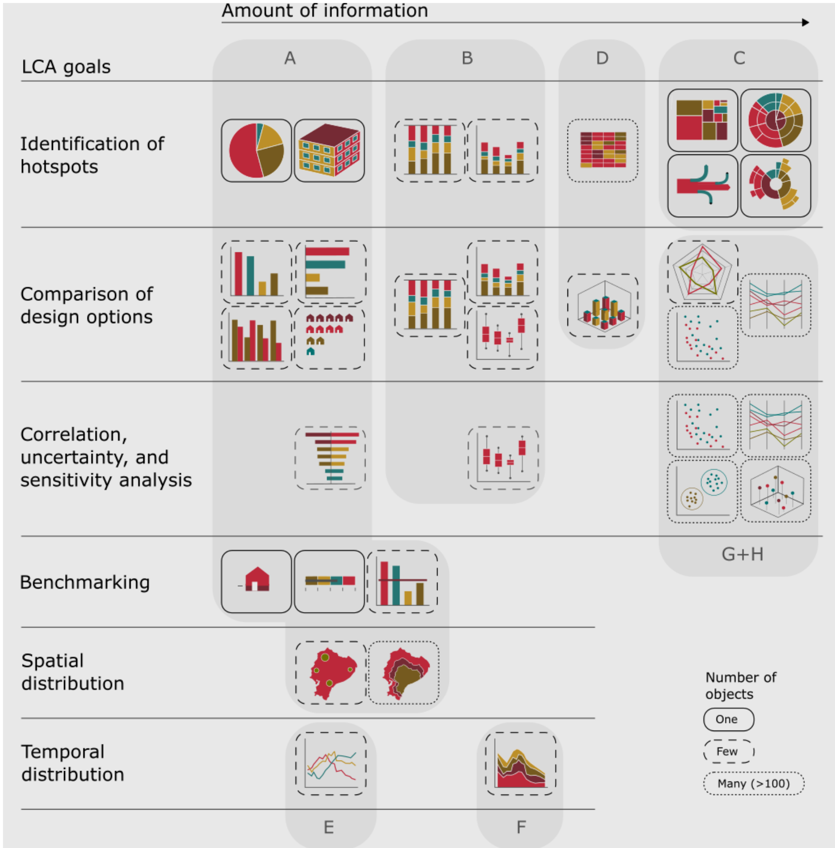
A selection process was developed to choose the most appropriate visualization type for the results

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

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



Review of visualising LCA results in the design process of buildings
Hollberg A., et al.. (2021) Review of visualising LCA results in the design process of buildings. In: Building and Environment, 190, 107530, https://doi.org/10.1016/j.buildenv.2020.107530.

Subtask 2: Main Results

Available from Spring 2023

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The Design Decision Table - Part 1

Design steps:

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

	0	1	2	3	4	5	6	7	8
	Early design			**Detailed design**				**Management**	
Design step definition	**Strategic definition**	**Preliminary studies**	**Concept Design**	**Developed Design**	**Technical Design**	**Manufacturing and Construction**	**Handover and commissioning**	**Operation and management**	**End of use, re-cycling**
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
Important to consider for reducing the environmental impacts	**Clarify the need for the building**	**Build less: Reduce area built where possible**	**Optimize the building shape design to reduce the energy demands as much as possible**	**Optimize the design of the building systems, especially structure and envelope**	**Optimize the design of the building services, finishings (and the rest of the building systems)**	**Coordinate actions of the stakeholders based on awareness about the environmental impacts**			
	Is a new building needed? Can an existing building be transformed/retrofitted instead?	Reduction or optimization of the built area to the minimum	Integration of passive and bioclimatic design strategies in the design of the building **volumes**	Integration of passive and bioclimatic design strategies in the design of the building **envelope**	Can I reduce or optimize the embodied and operational building impacts?				Can the materials to be demolished be reused/ recycled/upcycled/ downcycled?
				Can I reduce or optimize the material quantities in the building?	Which materials and construction systems enable to minimize transports, waste generation, construction and operational/use emissions?				
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**

general information

Subtask 2: Main Results

Available from Spring 2023

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The Design Decision Table - Part 2

Design steps:

- Task of the design stages
- Decomposition levels to be used
- Tools (BIM)
- Uncertainties
- Visualization types to be used
- Purpose of the LCA

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. 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.	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 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 certificate, 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	

Subtask 3: Case Studies

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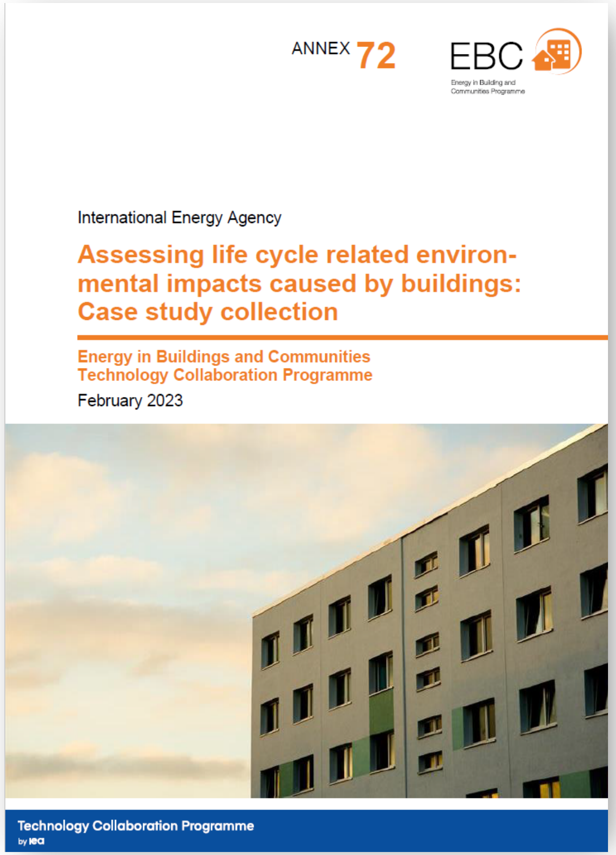
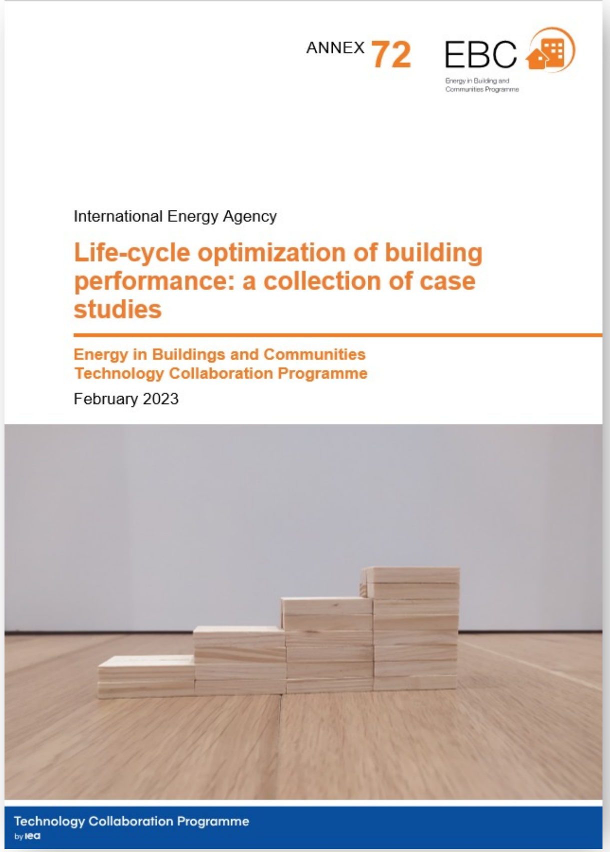
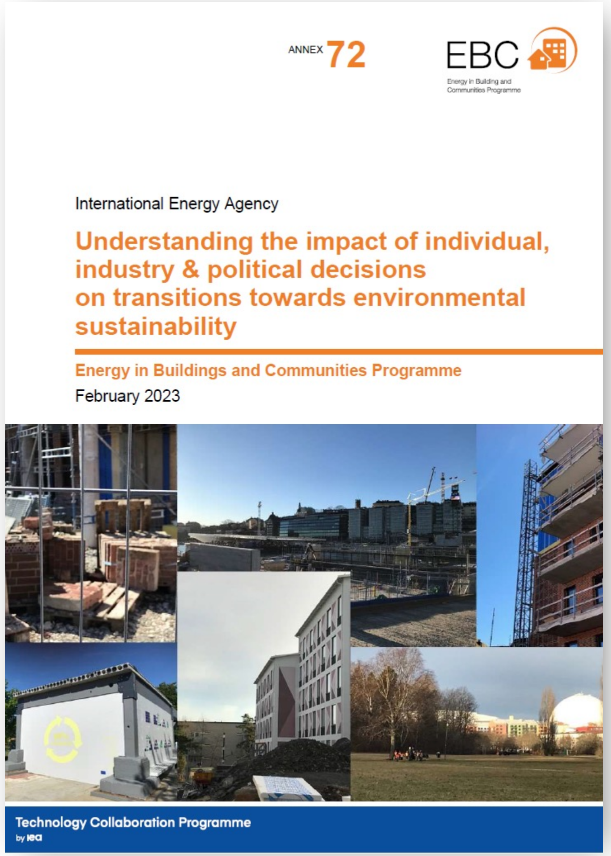






ANNEX 72 EBC
Energy in Buildings and Communities Programme

LCA and BIM: Visualization of environmental potentials in building construction at early design stages

Abstract

Purpose/aim

This case study showcases an approach using Building Information Modeling (BIM) to assess a wide range of construction options and their embodied environmental impact.

Method

We use a conceptual BIM model to evaluate a variety of material compositions for different building elements and the potential contribution of elements to the total embodied impact of the building design.

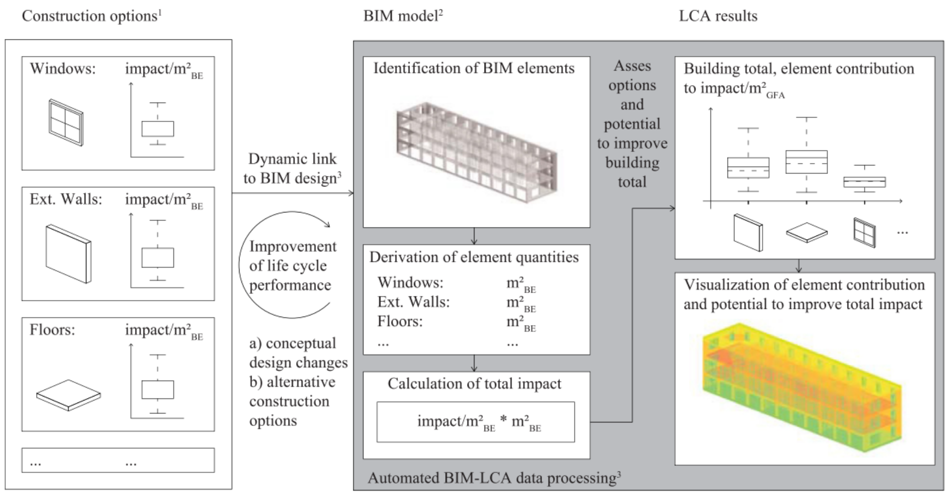
Results

Applying the method to a case study we can see that it allows to quickly identify which element has the greatest potential for improvement at the building scale and where to focus during a conceptual design stage.

Conclusions

The BIM-integrated approach enables identification of design specific hotspots which can be visualized on the building model for communication of LCA results and visual design guidance.

Fig. 1: Schematic workflow showing the link of aggregated LCA data for multiple construction options and BIM; Automated identification of element quantities and calculations of total embodied impact; Analysis and visualization of LCA results and improvement potential.



[1] Aggregated LCA database for building elements, e.g. MS Excel
[2] BIM model, e.g. Autodesk Revit
[3] Custom script, e.g. Autodesk Dynamo

Corresponding case study author: Martin Röck, Graz University of Technology, Austria (martin.roeck@tugraz.at)

Original publication: Röck M, Hollberg A, Habert G, Passer A. LCA and BIM: Visualization of environmental potentials in building construction at early design stages. Build Environ 2018;140:153–61. DOI: https://doi.org/10.1016/j.buildenv.2018.05.006

Comparison of the environmental assessment of an identical office building with national methods

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SUSTAINABLE BUILT ENVIRONMENT CONFERENCE 2019 (SBE19 Graz) IOP Publishing
IOP Conf. Series: Earth and Environmental Science **323** (2019) 012037 doi:10.1088/1755-1315/323/1/012037

Comparison of the environmental assessment of an identical office building with national methods

Frischknecht R[1], Birgisdottir H[2], Chae C-U[3], Lützkendorf T[4], Passer A[5], Alsema E[6], Balouktsi M[4], Berg B[7], Dowdell D[7], García Martínez A[8], Habert G[9], Hollberg A[9], König H[10], Lasvaux S[11], Llatas C[8], Nygaard Rasmussen F[2], Peuportier B[12], Ramseier L[1], Röck M[5], Soust Verdaguer B[8], Szalay Z[13], Bohne R A[14], Bragança L[15], Cellura M[16], Chau C K[17], Dixit M[18], Francart N[19], Gomes V[20], Huang L[14], Longo S[16], Lupíšek A[21], Martel J[22], Mateus R[15], Ouellet-Plamondon C[23], Pomponi F [24], Ryklová P[21], Trigaux D[25], Yang W[26]

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[4] Karlsruhe Institute of Technology, Germany
[5] Graz University of Technology, Austria
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[9] ETH Zurich, Switzerland
[10] Ascona, Germany
[11] HES-SO, IGT-LESBAT, Switzerland
[12] MINES ParisTech, France
[13] Budapest University of Technology and Economics, Hungary
[14] NTNU – Norwegian University of Science and Technology, Norway
[15] University of Minho, Portugal
[16] University of Palermo, Italy
[17] The Hong Kong Polytechnic University, Hong-Kong
[18] Texas A&M University, USA
[19] KTH Royal Institute of Technology, Sweden
[20] University of Campinas, Brazil
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[22] Groupe Ageco, Canada
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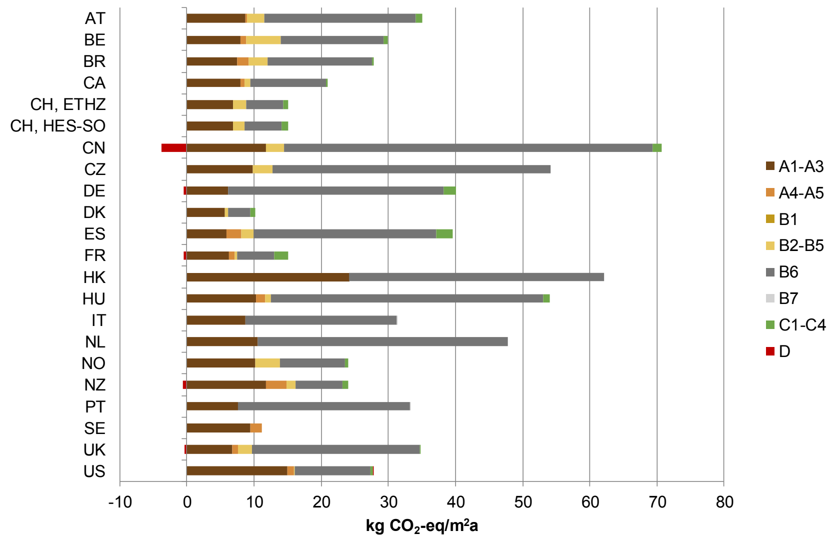

Figure 5. Greenhouse gas emissions in kg CO_2-eq per m^2 and year of the reference building "be2226" assessed according to the national/regional approaches of the countries listed (preliminary results).

DIGITALES BAUWERKS-MODELL

Veröffentlichte Dateitypen:
Autodesk Revit 2020
IFC2X3-Koordinationsansicht

Materialien:
ca. 50

IFC-Elementtypen:
insgesamt ca. 9290

BIM MODEL AGNHB - BIM model 2021

Inffeldgasse 13, PZ02, BIM Model

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Energy in Buildings and Communities Programme

- Inffeldgasse 13_PZ02_Produktionstechnikzentrum 2_BIM Model_IFC4
  Lizenz: CC BY-NC-ND 4.0
- Inffeldgasse 13_PZ02_Produktionstechnikzentrum 2_BIM Model_IFC2x3_2.0
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- 20210513_documentationInffeldgasse13
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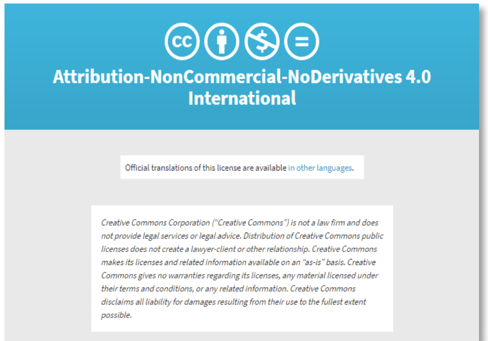
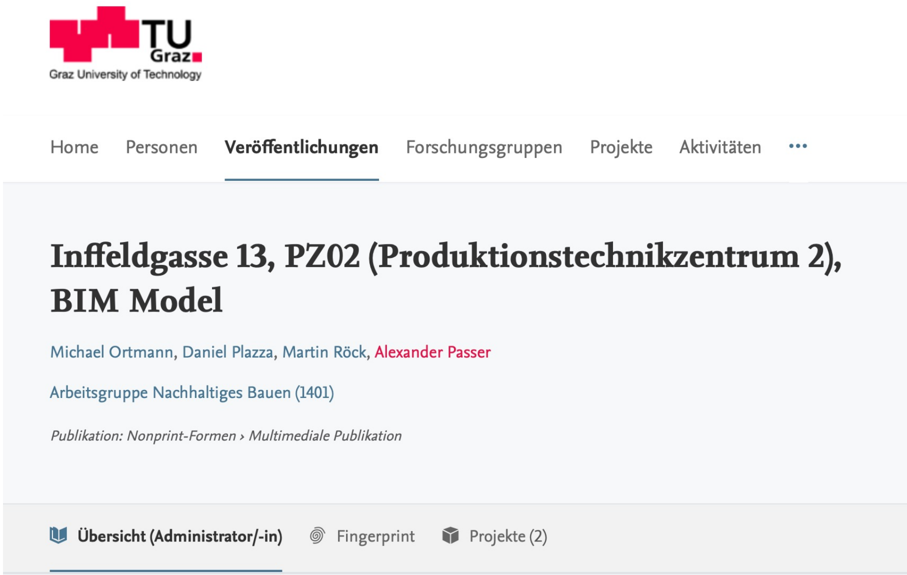


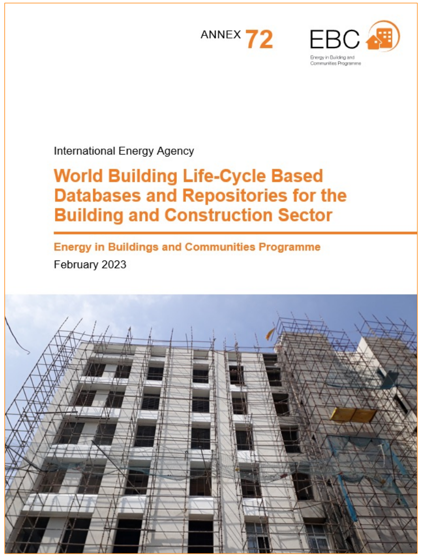


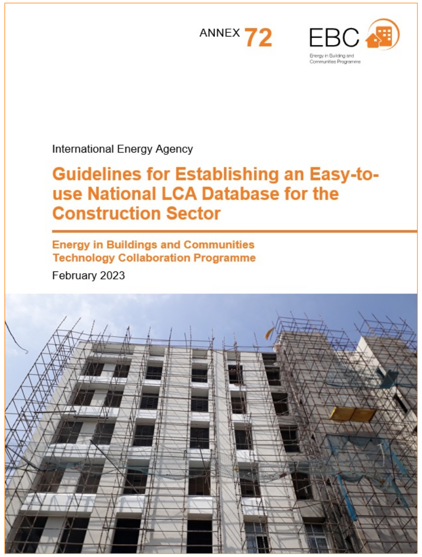
https://graz.pure.elsevier.com/de/publications/inffeldgasse-13-pz02-produktionstechnikzentrum-2-bim-model

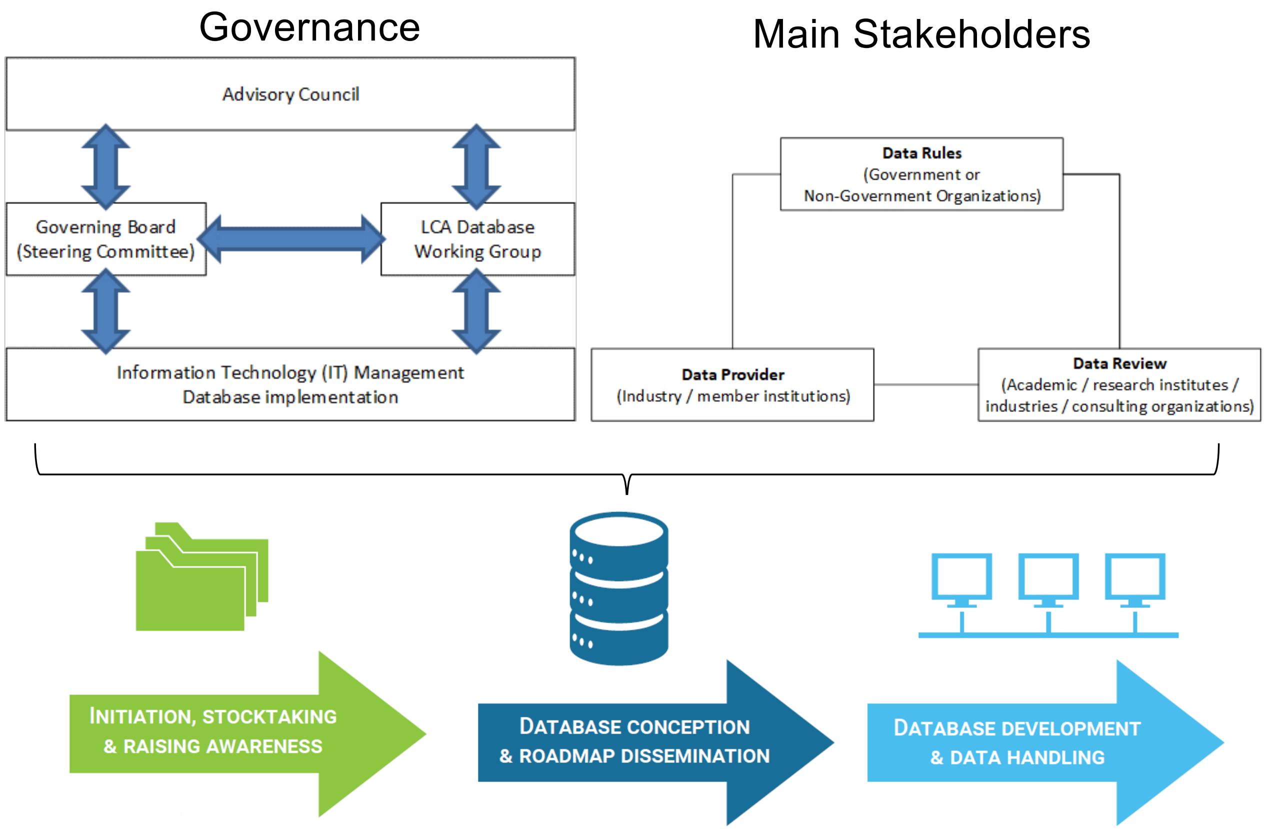
Subtask 4: LCA databases

ANNEX 72 EBC
Energy in Buildings and Communities Programme

- Global survey on LCA database situation
- Guidelines on how to establish an LCA database for the construction sector







Deliverables Available Q2 2023 on:

https://annex72.iea-ebc.org/

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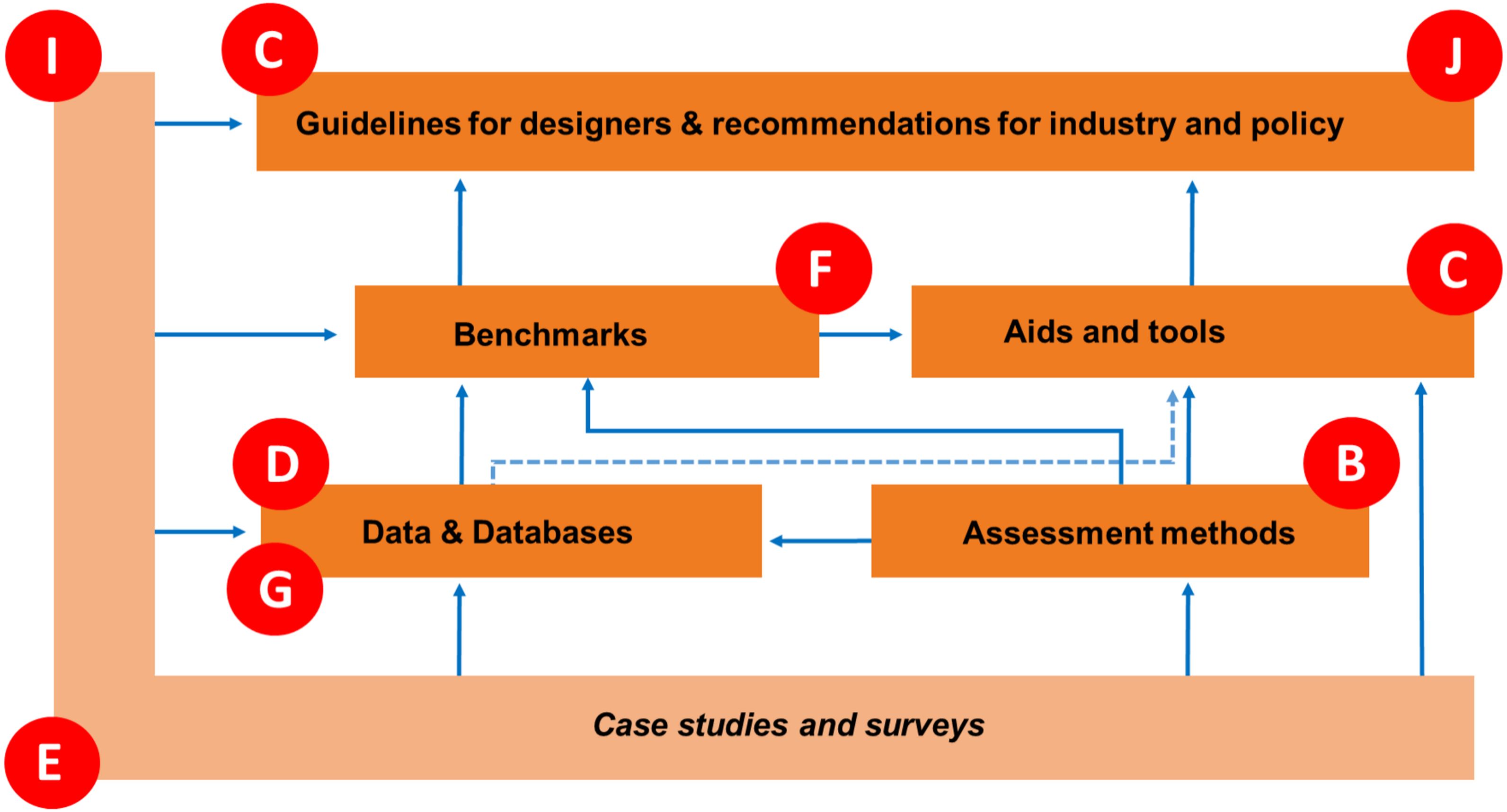
Energy in Buildings and Communities Programme



Official Deliverables (Reports)

Nr.	Title
B	Report on Context-specific **methods guidelines** on the environmental life cycle assessment of buildings, including biogenic carbon assessment
C	Report on **guidelines for designers** on how to optimise the life cycle performance of buildings **using design tools** such as BIM
D	Report on **national LCA databases** used in the construction sector
E	Report on **building case studies**
F	Report on **environmental benchmarks** of buildings, including zero emission buildings
G	Report on **how to establish an LCA database** targeted to the construction sector
I	**Optimisation** case studies
J	Understanding the impact of individual, industry & political **decisions** on transitions **towards environmental sustainability**
	Annex 72 Summary Report

The Monte Verità Declaration

On a built environment within planetary boundaries

ANNEX 72 EBC
Energy in Buildings and Communities Programme

Signed by **40+ scientists** from **25 countries** worldwide (Europe, Asia, Americas, Oceania)

Introduce **legally binding maximum target values** for GHG-emissions of **new constructions and of refurbishments by 2025** latest with a roadmap **to net zero by 2035.**

ANNEX 72 EBC

Monte Verità Declaration on a built environment within planetary boundaries

Outcome of IEA EBC Annex 72

0 Preamble

Buildings substantially contribute to and influence the quality of life. At the same time, they are one key element to help achieving several of the Sustainable Development Goals launched by UN Environment, in particular #11 Sustainable Cities and Communities, #12 Sustainable Consumption and Production and #13 Climate Action. A comprehensive assessment of buildings addresses the environmental, the social and the economic performance. The environmental dimension covers life cycle based impacts such as climate change caused by greenhouse gas emissions along the life cycle of buildings, impacts on the local environment and potential health risks e.g. due to indoor air quality.

The declaration and its recommendations focuse on the life cycle based environmental impacts and resource consumption, the core topic of the experts and their research institutes co-operating in IEA EBC Annex 72. While this declaration has a special focus on greenhouse gas emissions, further environmental impacts including resource consumption are also addressed to avoid burden shifting.

The experts co-operating in the IEA EBC Annex 72 "Assessing Life Cycle Related Environmental Impacts Caused by Buildings" acknowledge that

- mankind is responsible for the rapidly increasing global temperature which is causing severe human suffering and irreparable damages on fragile ecosystems.
- CO_2 emissions need to be urgently and drastically reduced and globally reach net zero well before 2050 to stay within the remaining global budget which increases the likeliness that the global temperature increase stays below 1.5°C.[1]
- the emissions of all other greenhouse gases (GHG) need to be reduced similarly.
- the planetary boundaries are exceeded with respect to pressure on biodiversity, nitrogen and phosphorous flows.
- freshwater is overused in several regions of the world.
- the concentration of aerosols (air quality) is far too high in many metropolitan areas and agglomerations of the world.
- Buildings put pressure on local and global natural resources
- buildings are causing about 40 % of global CO_2 emissions, either directly, or indirectly via the energy and the construction materials sectors.
- buildings, building related infrastructures and their supply chains are one driver for land use and land use change and landscape fragmentation and subsequent biodiversity losses.
- airborne pollutants emitted by the construction material industries are contributing substantially to the impairment of outdoor air quality.

[1] The emissions of other greenhouse gases need to be reduced to similarly low levels. That is why this Declaration addresses greenhouse gas emissions instead of CO_2 only.

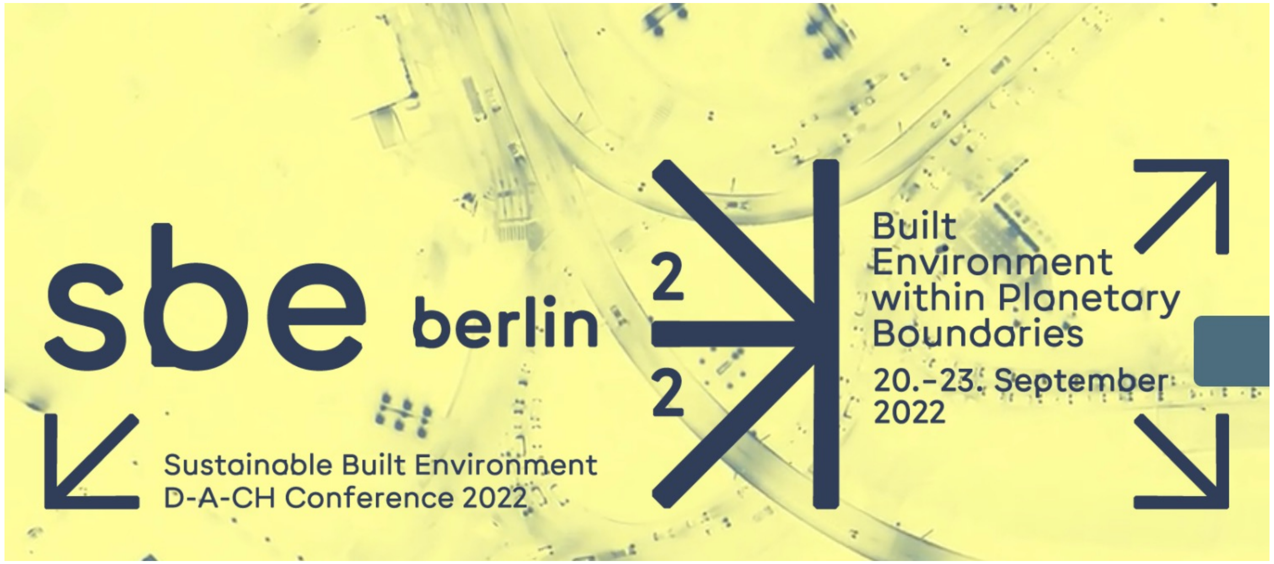
Table of Contents

ANNEX 72

EBC
Energy in Buildings and Communities Programme

Dissemination Events

- SBE BERLIN
  - Special session to present Annex 72 results
- Common methodology guidelines
- Methods for the development of and case studies for deriving empirical environmental benchmarks
- Guidelines how to use building design and planning tools
- Guidelines to establish national/regional databases and share national experiences



Buildings LCA and digitalization: Designers' toolbox based on a survey. Di Bari, R., Horn, R., Bruhn, S., Alaux, N., Ruschi Mendes Saade, M., Soust-Verdaguer, B., Potrč Obrecht, T., Hollberg, A., Birgisdottír, H., Passer, A. & Frischknecht, R., 2022, In: IOP Conference Series: Earth and Environmental Science. 1078, 1, 012092.

Output - Publications

Conference Papers Published on Following Important Conferences

- D-A-CH SBE 22 - Sustainable Built Environment - For a Built Environment Within Planetary Boundaries, 20-23 September 2022, Berlin, Germany
- CESB 22 - Sustainable Built Environment - Central Europe towards Sustainable Building, 4-6 July 2022, Prague, Czech Republic
- Pre COP 26 - Climate Expo, 17-21 May 2021, Glasgow, UK
- WSBE 20 - World Sustainable Built Environment - Beyond2020 2-4 November 2020, Gothenburg, Sweden
- SUSTAINABLE BUILT ENVIRONMENT D-A-CH CONFERENCE 2019 (SBE19 Graz) 11–14 September 2019, Graz, Austria
- Sixth International Symposium on Life-Cycle Civil Engineering, Ghent, Belgium, October 2018

Output - Publications

Most cited Paper

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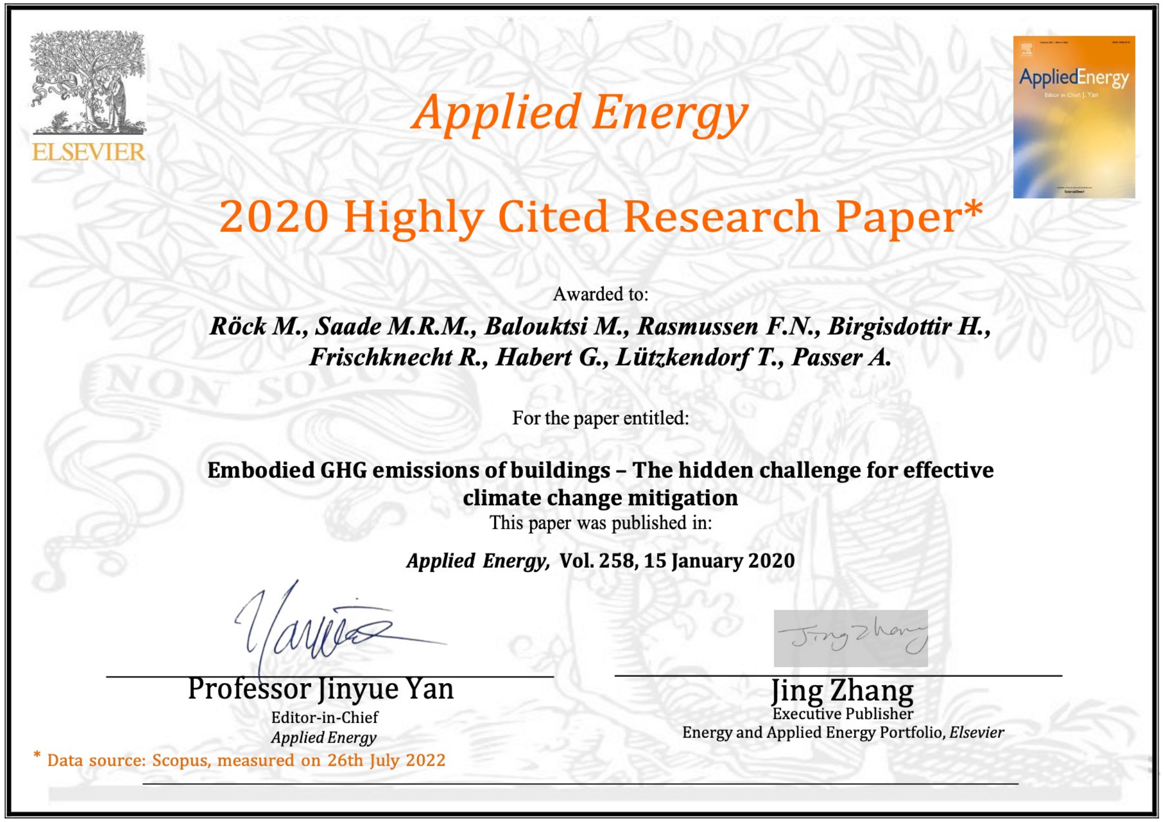
ELSEVIER

Applied Energy

2020 Highly Cited Research Paper*

Awarded to:

Röck M., Saade M.R.M., Balouktsi M., Rasmussen F.N., Birgisdottir H., Frischknecht R., Habert G., Lützkendorf T., Passer A.

For the paper entitled:

Embodied GHG emissions of buildings – The hidden challenge for effective climate change mitigation

This paper was published in:

***Applied Energy*, Vol. 258, 15 January 2020**

Professor Jinyue Yan
Editor-in-Chief
Applied Energy

Jing Zhang
Executive Publisher
Energy and Applied Energy Portfolio, *Elsevier*

* Data source: Scopus, measured on 26th July 2022

- **Embodied GHG emissions of buildings – The hidden challenge for effective climate change mitigation**
  Röck M., Saade M. R. M., Balouktsi M., Rasmussen F. N., Birgisdottir H., Frischknecht R., Habert G., Lützkendorf T. and Passer A. (2020)

Output - Publications

Journal Papers

ANNEX 72 EBC Energy in Buildings and Communities Programme

Publications List available at: https://annex72.iea-ebc.org/journal-and-conference-papers

Austrian contributions to Annex 72 | Annex 72

- **Using systematic building decomposition for implementing LCA: The results of a comparative analysis as part of IEA EBC Annex 72.** Soust-Verdaguer, B., Obrecht, T. P., Alaux, N., Hoxha, E., Saade, M. R. M., Röck, M., Garcia-Martinez, A., Llatas, C., Gómez de Cózar, J. C. & Passer, A., 15 Jan. 2023, in: Journal of Cleaner Production. 384, 135422.
- **Climate mitigation in the Swedish single-family homes industry and potentials for LCA as decision support**
Brismark J., Malmqvist T., Borgström S. (2022) Climate mitigation in the Swedish single-family homes industry and potentials for LCA as decision support. In: Buildings, 12 (5), 588. https://doi.org/10.3390/buildings12050588
- **Influence of methodological choices on maintenance and replacement in building LCA**
Francart N., Widström T., & Malmqvist T. (2021). Influence of methodological choices on maintenance and replacement in building LCA. The International Journal of Life Cycle Assessment. https://doi.org/10.1007/s11367-021-01985-z.

Output - Publications

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Energy in Buildings and Communities Programme

Journal Papers

- **Review of visualising LCA results in the design process of buildings**
  Hollberg A., Kiss B., Röck M., Soust-Verdaguer B., Wiberg A. H., Lasvaux S., Galimshina A., Habert G. (2021) Review of visualising LCA results in the design process of buildings. In: Building and Environment, 190, 107530, https://doi.org/10.1016/j.buildenv.2020.107530.
- **Review of visualising LCA results in the design process of buildings**
  Galimshina A., Moustapha M., Hollberg A., Padey P., Lasvaux S., Sudret B., Habert G. (2021) Review of visualising LCA results in the design process of buildings. In: Energy and Buildings, 2021, https://doi.org/10.1016/j.enbuild.2021.111329.
- **Environmental modelling of building stocks – An integrated review of life cycle-based assessment models to support EU policy making**
  Röck M., Baldereschi E., Verellen E., Passer A., Sala S., Allacker K. (2021) Environmental modelling of building stocks – An integrated review of life cycle-based assessment models to support EU policy making. In: Renew Sustain Energy Rev, 2021;151, https://doi.org/10.1016/j.rser.2021.111550.

Output - Publications

Journal Papers

- **Dataset of service life data for 100 building elements and technical systems including their descriptive statistics and fitting to lognormal distribution**
  Goulouti K., Favre D., Giorgi M., Padey P., Galimshina A., Habert G., & Lasvaux S. (2021) Dataset of service life data for 100 building elements and technical systems including their descriptive statistics and fitting to lognormal distribution. In: Data in Brief, 36, 107062.
- **How to define (net) zero greenhouse gas emissions buildings: The results of an international survey as part of IEA EBC annex 72**
  Satola D., Balouktsi M., Lützkendorf T., Wiberg A. H. and Gustavsen A. (2021) How to define (net) zero greenhouse gas emissions buildings: The results of an international survey as part of IEA EBC annex 72. In: Building and Environment, 192, pp. 107619.
  DOI: https://doi.org/10.1016/j.buildenv.2021.107619.
- **Life cycle GHG emissions of residential buildings in humid subtropical and tropical climates: Systematic review and analysis**
  Satola D., Röck M., Houlihan-Wiberg A., Gustavsen A. (2021) Life cycle GHG emissions of residential buildings in humid subtropical and tropical climates: Systematic review and analysis. In: Buildings 2021;11:1–36. https://doi.org/10.3390/buildings11010006.

Output - Publications

Journal Papers

- **Carbon budgets for buildings: Harmonizing temporal, spatial and sectoral dimensions**
  Habert G., Röck M., Steininger K., Lupisek A., Birgisdottir H., Desing H., et al. (2020) Carbon budgets for buildings: Harmonizing temporal, spatial and sectoral dimensions. In: Build Cities 2020:1–24. https://doi.org/10.5334/bc.47.
- **Embodied GHG emissions of buildings – The hidden challenge for effective climate change mitigation**
  Röck M., Saade M. R. M., Balouktsi M., Rasmussen F. N., Birgisdottir H., Frischknecht R., Habert G., Lützkendorf T. and Passer A. (2020) Embodied GHG emissions of buildings – The hidden challenge for effective climate change mitigation. In: Applied Energy, 258(114107).
  DOI: https://doi.org/10.1016/j.apenergy.2019.114107.
- **(Net-) zero-emission buildings: a typology of terms and definitions** Lützkendorf, T. and Frischknecht, R., 2020. (Net-) zero-emission buildings: a typology of terms and definitions. Buildings and Cities, 1(1), pp.662–675. DOI: http://doi.org/10.5334/bc.66.
- **BIM and LCA Integration: A Systematic Literature Review**
  Potrč Obrecht T., Röck M., Hoxha E. and Passer A. (2020) BIM and LCA Integration: A Systematic Literature Review. In: Sustainability, 12(14), pp. 5534. DOI: https://doi.org/10.3390/su12145534.

Output - Publications

Journal Papers

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- **Multicriteria-Oriented Optimization of Building Energy Performances: The Annex 72 IEA-EBC Experience**
  Montana F., Longo S., Birgisdottir H., Cellura M., Frischknecht R., Guarino F., Kiss B., Peuportier B., Recht T., Riva Sanseverino E., Szalay Zs. (2021) Multicriteria-Oriented Optimization of Building Energy Performances: The Annex 72 IEA-EBC Experience. In: Energy systems evaluation (volume 2) (pp. 239-260). Springer, Cham.
- **Implementing Life Cycle Sustainability Assessment during design stages in Building Information Modelling: From systematic literature review to a methodological approach**
  Llatas C., Soust-Verdaguer B. and Passer A. (2020) Implementing Life Cycle Sustainability Assessment during design stages in Building Information Modelling: From systematic literature review to a methodological approach. In: Building and Environment, 182, pp. 107164.
  DOI: https://doi.org/10.1016/j.buildenv.2020.107164.

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Thank you!

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