Biogenic carbon modelling and assessment in buildings LCA:
the IEA EBC Annex72 consensus

Alexander Passer
Marcella Ruschi Saade

June 9th, 2022

Biogenic carbon modelling and assessment in buildings LCA

Modelling biogenic carbon

- 0/0 approach
- -1/+1 approach / -1/+1* approach
- Time-dependent approach

Implications of approaches on life cycle inventory and life cycle impact assessment

Key messages and recommendations

Discussion

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

ANNEX 72

EBC

Energy in Buildings and Communities Programme

Carbon footprint assessment of a wood multi-residential building considering biogenic carbon

Claudiane M. Ouellet-Plamondon[1], Livia Ramseier[2], Maria Balouktsi[3], Laetitia Delem[4], Greg Foliente[5], Nicolas Francart[6], Antonio Garcia[7], Endrit Hoxha[8], Thomas Lützkendorf[3], Freja Nygaard Rasmussen[9], Bruno Peuportier[10], Jared Butler[11], Harpa Birgisdottir[9], David Dowdell[11], Manish Dixit[12], Vanessa Gomes[13], Maristela Gomes da Silva[14], Juan Carlos Gómez[7], Marianne Kjendseth Wiik[15], Carmen Llatas[7], Ricardo Mateus[16], Lizzie M. Pulgrossi[13], Martin Röck[8,17], Marcella Ruschi Mendes Saade[8], Alexander Passer[8], Daniel Satola[18], Seongwon Seo[5], Bernadette Soust Verdaguer[7,8], Jakub Veselka[19], Martin Volf[19], Xiaojin Zhang[20], Rolf Frischkenecht[2]

[1] École de technologie supérieure, Montreal, Canada
[2] Treeze Ltd, CH- 8610 Uster, Switzerland
[3] Karlsruhe Institute of Technology, 76131 Karlsruhe, Germany
[4] Belgian Building Research Institute, 1000 Bruxelles, Belgium
[5] The University of Melbourne, Parkville VIC 3010, Australia
[6] KTH - Royal Institute of Technology, 114 28 Stockholm, Sweden
[7] Universidad de Sevilla, 41004 Sevilla, Spain
[8] Graz University of Technology, 8010 Graz, Austria
[9] Aalborg Universitet København, Aalborg Universitet København
[10] MINES ParisTech, PSL Research University, CES, 75272 Paris
[11] BRANZ, Judgeford 5381, New Zealand
[12] Texas A&M University, College Station, TX 77843
[13] University of Campinas, 13083-852, Campinas
[14] Federal University of Espirito Santo, 2907
[15] SINTEF, NO-7465 Trondheim, Nor
[16] University of Minho, 4710-05
[17] KU Leuven, 3001 Leuve
[18] Norwegian University of S ology, 7491 Trondheim, Norway
[19] University Centre for Energ Buildings, Czech Technical University in Prague, 273 43, Bustehrad, Czechia
[20] Paul Scherrer Institute, 5232 Villigen, Switzerland

Under review

List of “methodological questions” in LCA of buildings


Functional equivalent


Completeness of building description


Cut-off criteria: life cycle stages


Energy mix evolution


Innovation and progress of products


Energy mix modelling


Modelling of PV electricity


Demarcation: building vs. user consumption


Changing climate


Influence of users in building operation


Operational water consumption


Building-induced mobility


Pros and cons of discounting


Indicators issues


Components: further use in refurbishment


Uncertainty, sensitivity, ranges

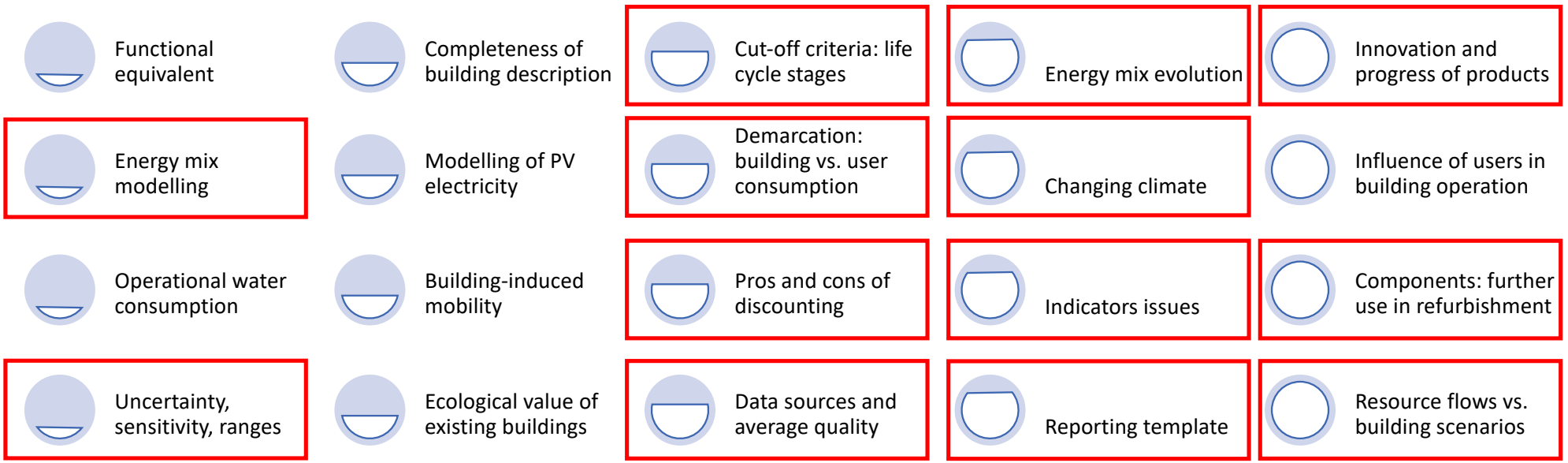

Ecological value of existing buildings


Data sources and average quality


Reporting template


Resource flows vs. building scenarios

List of “methodological questions” in LCA of buildings

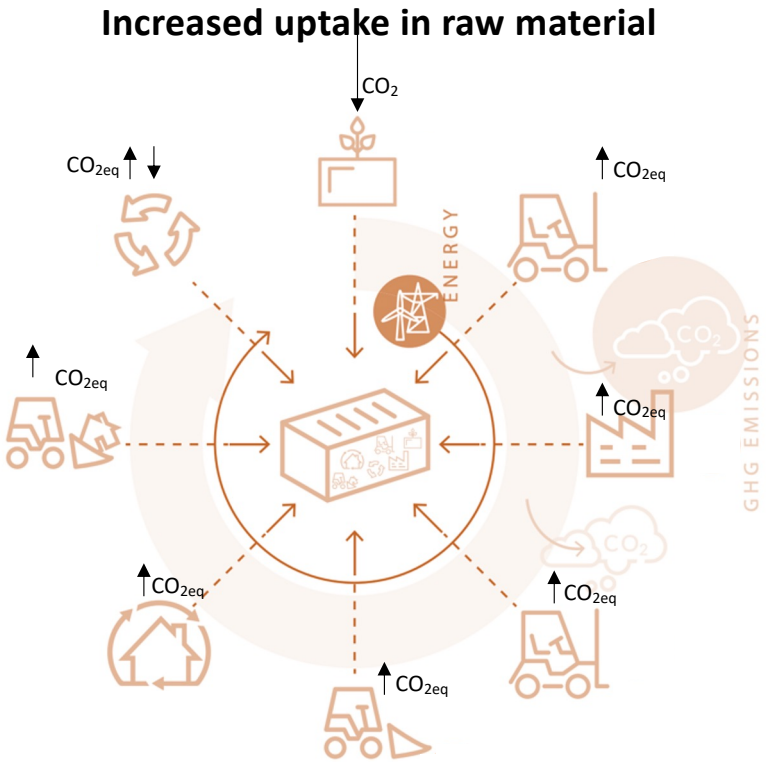


Biogenic carbon - directly or indirectly related

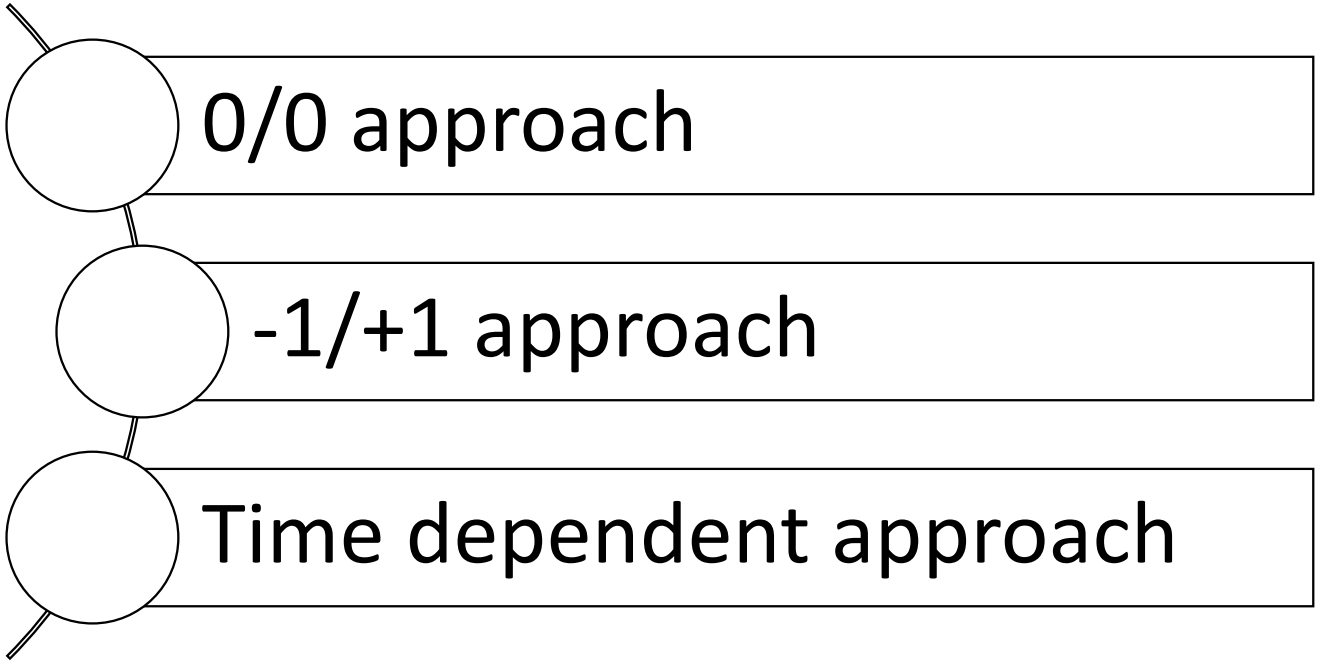
Main documents (reference)	Type of approach	Biogenic carbon uptake	Biogenic carbon storage	Biogenic carbon release	Direct land use change	Indirect land use change	Additional LCI indicators on biogenic carbon
		Module A	Module B	Module C	Module A	Module A	
EC (2013b)	-1/+1	Yes	No. May be documented separately.	Yes	Yes	No	No requirements
ISO 14067 (2018)	-1/+1	Yes	No. May be documented separately.	Yes	Yes	No	Biogenic carbon content documented separately
ISO/DIS 14067 (2018)	-1/+1	Yes	No. May be documented separately.	Yes	Yes	No	Biogenic carbon content documented separately
EC (2017a, 2017b)	0/0	No	No. Credit for permanent.	Partially	Yes	No	Biogenic carbon content documented separately
PAS 2050 (2011)	-1/+1	Yes	No. Credit for permanent.	Yes	Yes	No	No requirements
ILCD (2010)	-1/+1	Yes	No	Yes	Not specified	No	No requirements
ISO 21930 (2017)	-1/+1	Yes	No. May be documented separately.	Yes	Yes	Not specified	Carbon uptake and emissions for biogenic carbon and carbonation
EN 15804 (2019)	-1/+1	Yes	No	Yes	Yes	Not specified	Biogenic carbon content
EN 16485 (2014)	-1/+1	Yes	No. May be documented separately.	Yes	Yes	No	Biogenic carbon content documented separately
Levasseur et al (2013)	time dependent approach	Time-dependent approach approach with time-dependent characterisation factors for all emissions (fossil and biogenic), allowing for the consideration of the effects of delayed emissions and carbon storage					
Vogtländer et al (2014)	time dependent approach	Approach based on the global carbon style-benefit of carbon sequestration when there is a global growth of forest and a simultaneous growth of wood					
Cherubini et al (2011); Guest et al (2013)	time dependent approach	Biogenic global warming potential (GWP bio) considering the effect of forest regrowth and carbon storage					

Biogenic carbon modelling

- Full life cycle approach (life cycle assessment)
- Modularity principle
- Balance must be properly addressed and interpreted!
- **How to account for carbon uptake and emissions?**
- Three options for assessment rules are available.



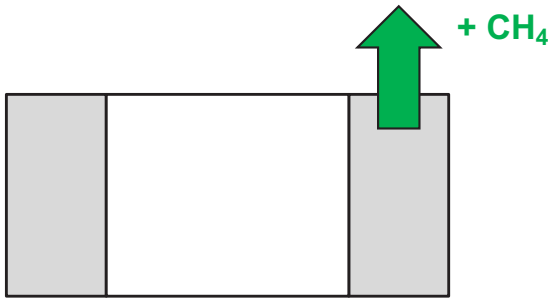
IEA EBC Annex 57 - http://www.annex57.org/wp/wp-content/uploads/2017/05/Guideline-for-Manufactu rer.pdf


0/0 approach
-1/+1 approach
Time dependent approach

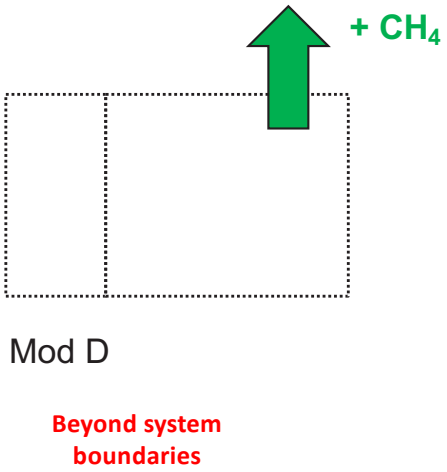
The 0/0 approach

Forest system

Building system

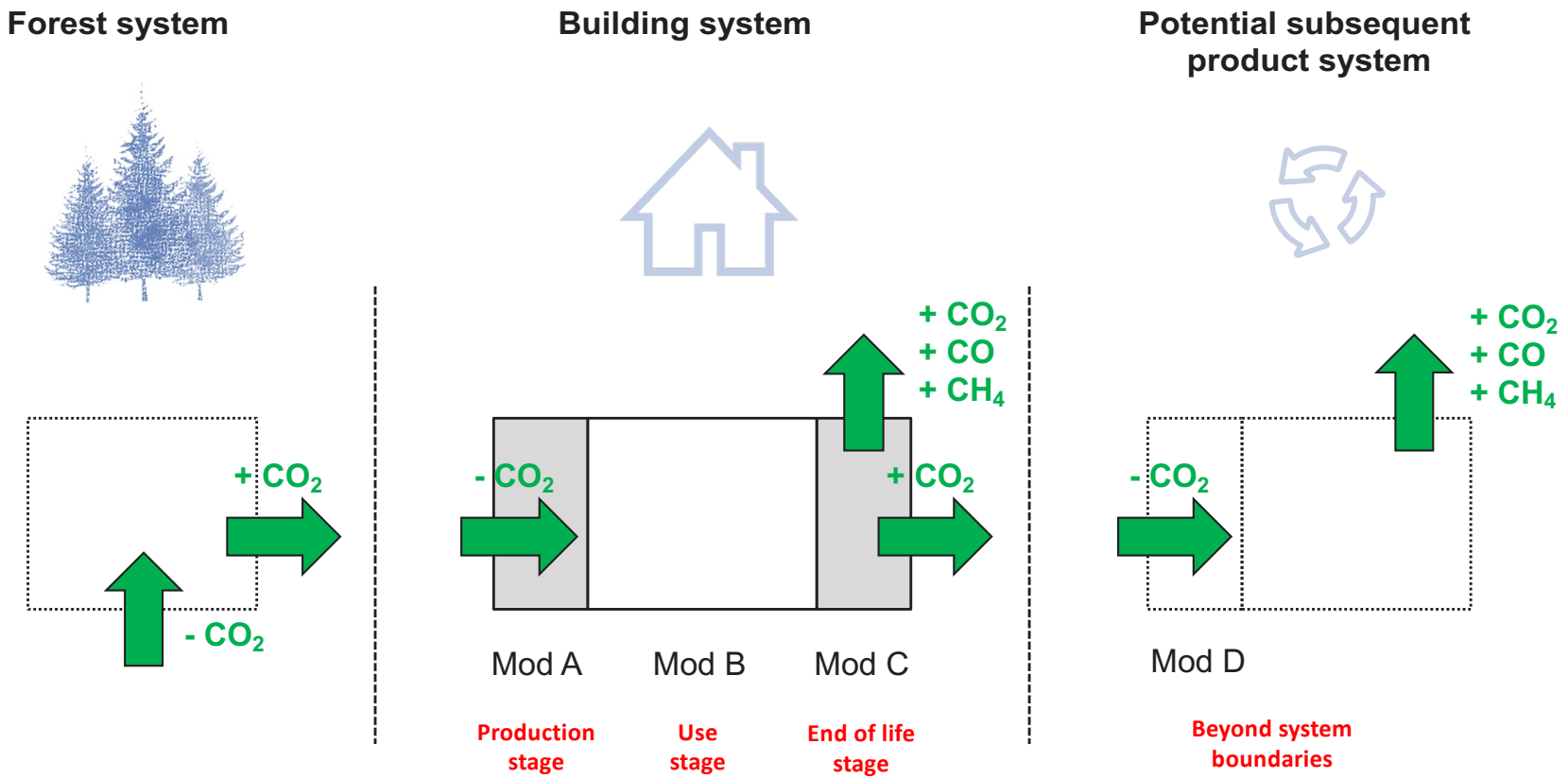


Potential subsequent product system



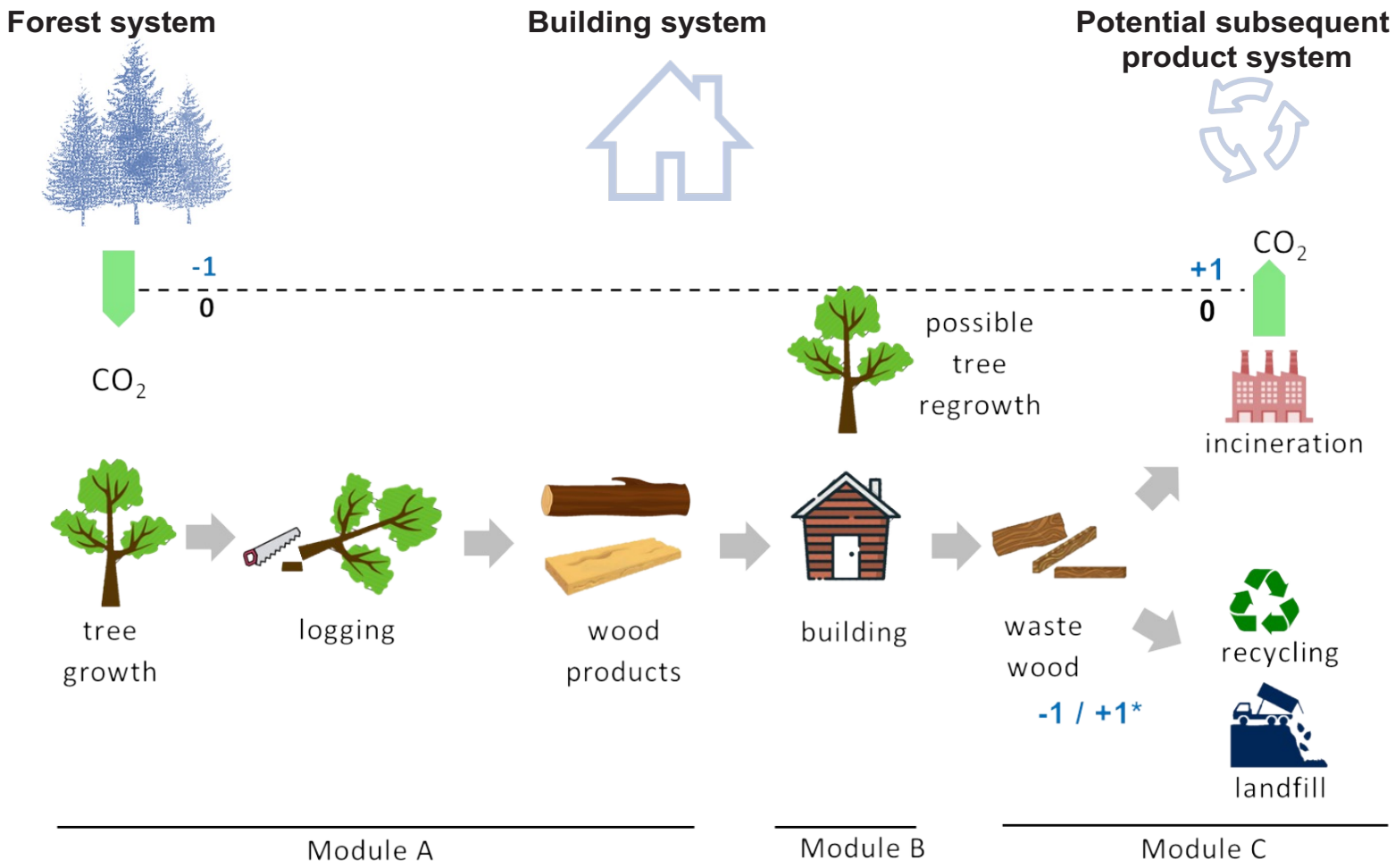
Hoxha, E., Passer, A., Saade, M.R.M., Trigaux, D., Shuttleworth, A., Pittau, F., Allacker, K., Habert, G., 2020. Biogenic carbon in buildings: a critical overview of LCA methods. Build. Cities 1, 504–524. https://doi.org/10.5334/bc.46

The -1/+1 approach



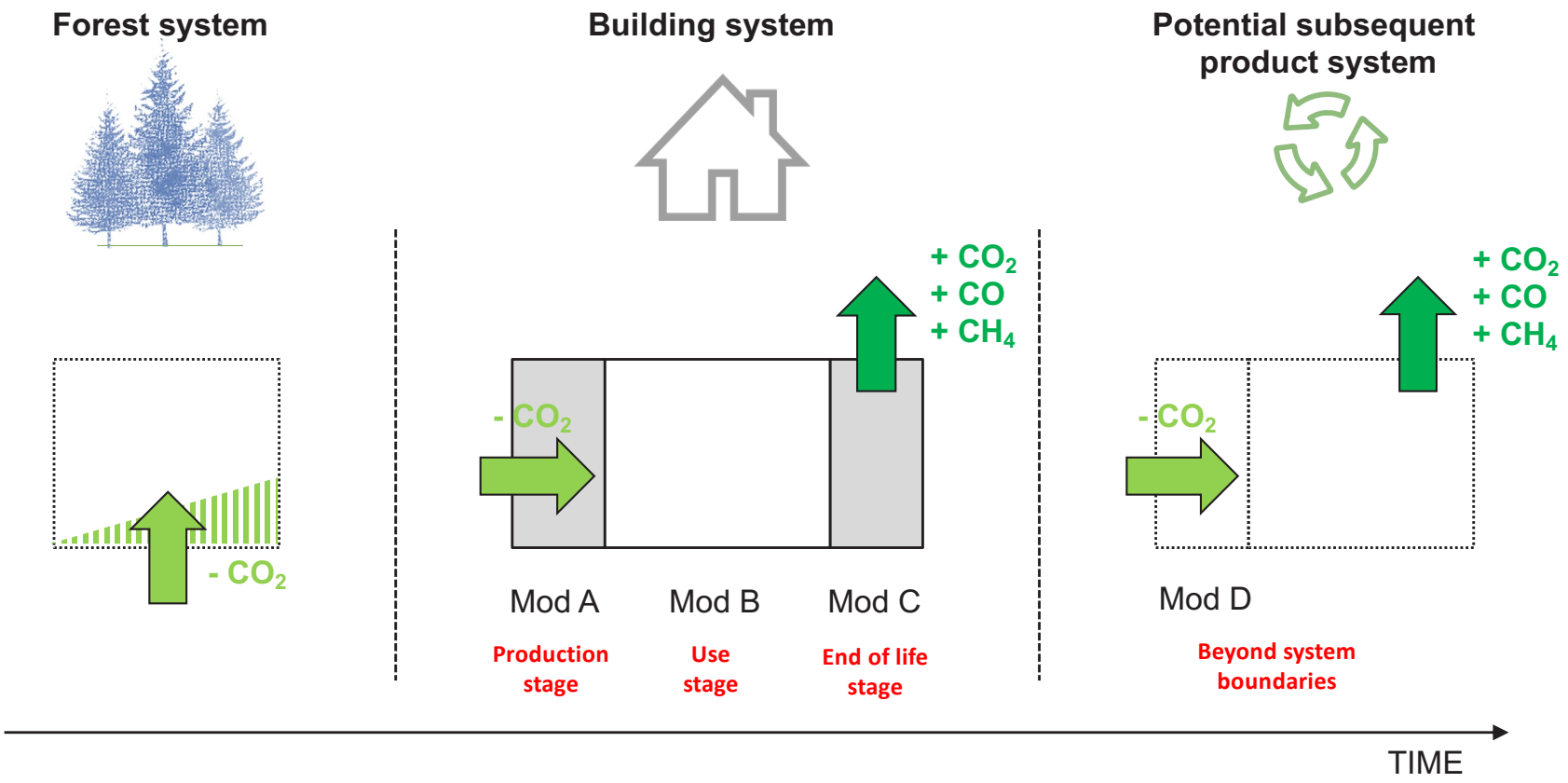
Hoxha, E., Passer, A., Saade, M.R.M., Trigaux, D., Shuttleworth, A., Pittau, F., Allacker, K., Habert, G., 2020. Biogenic carbon in buildings: a critical overview of LCA methods. Build. Cities 1, 504–524. https://doi.org/10.5334/bc.46

The -1/+1* approach



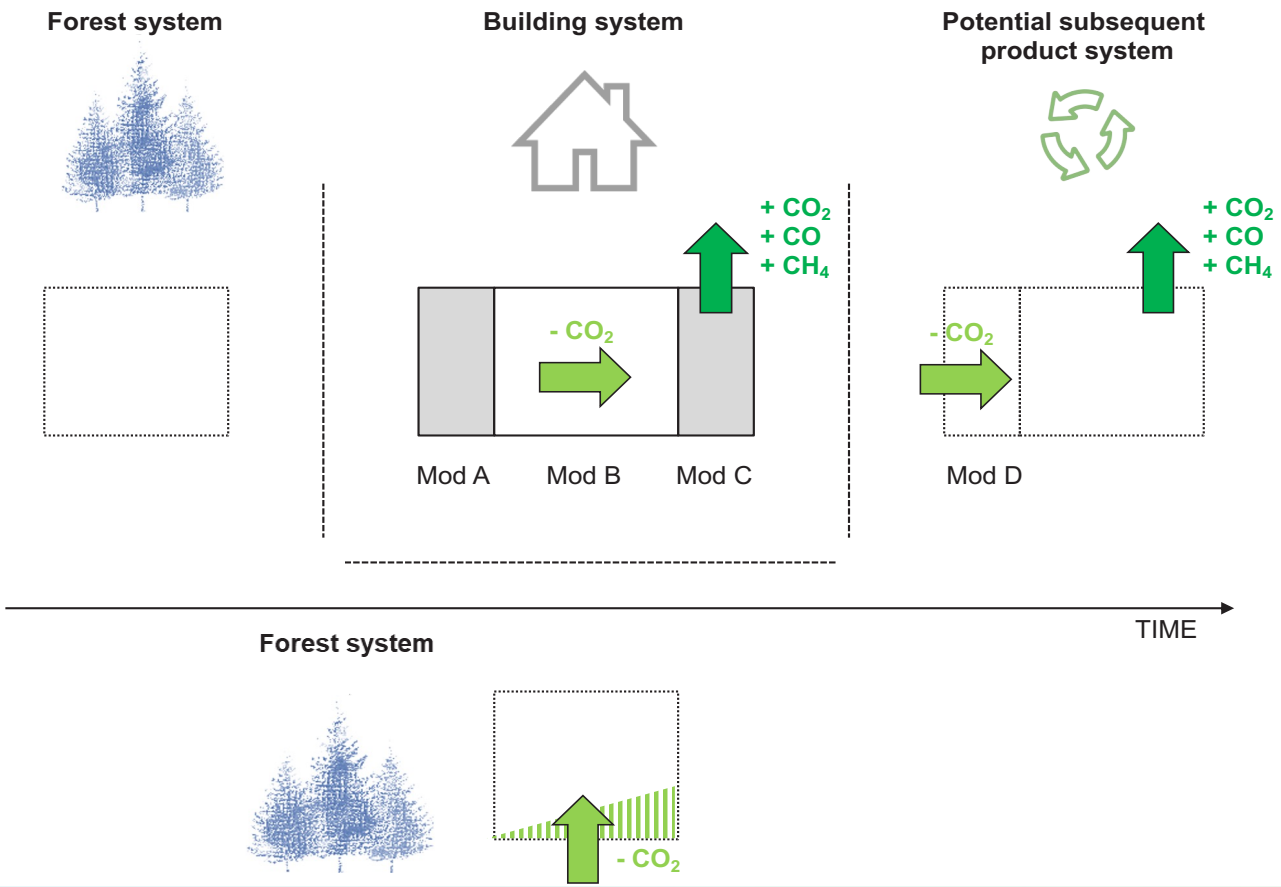
Ouellet-Plamondon, Claudiane et al. (unpublished)

The time dependent approach – growth before harvest



Hoxha, E., Passer, A., Saade, M.R.M., Trigaux, D., Shuttleworth, A., Pittau, F., Allacker, K., Habert, G., 2020. Biogenic carbon in buildings: a critical overview of LCA methods. Build. Cities 1, 504–524. https://doi.org/10.5334/bc.46

The time dependent approach – growth after harvest



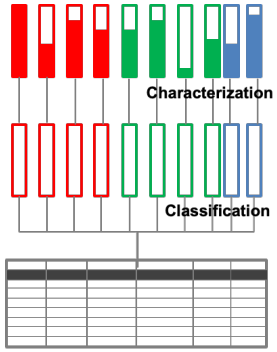
Hoxha, E., Passer, A., Saade, M.R.M., Trigaux, D., Shuttleworth, A., Pittau, F., Allacker, K., Habert, G., 2020. Biogenic carbon in buildings: a critical overview of LCA methods. Build. Cities 1, 504–524. https://doi.org/10.5334/bc.46

Implications

- 0/0 approach
- -1/+1 approach
- Time dependant approach

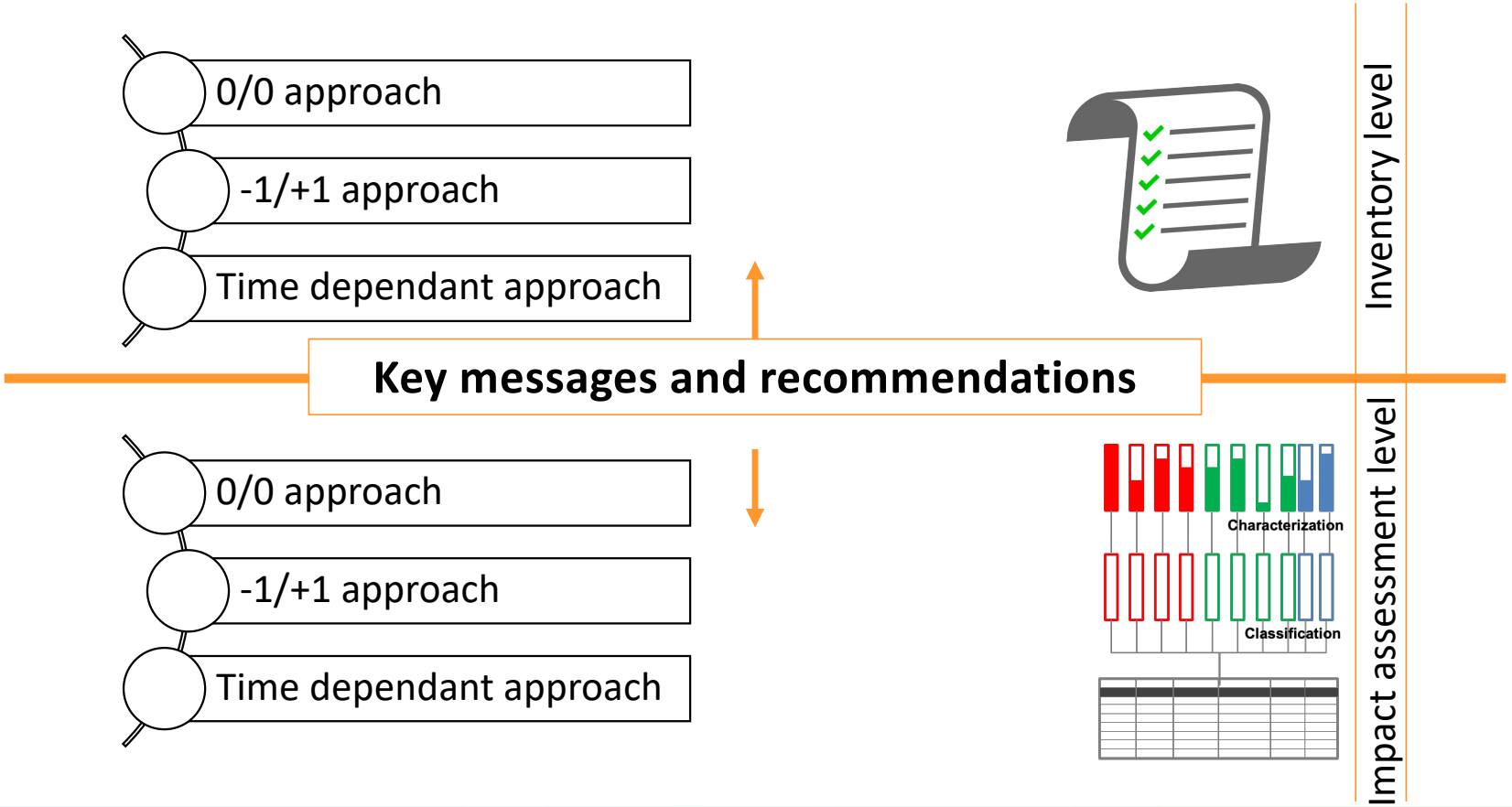
Inventory level

- 0/0 approach
- -1/+1 approach
- Time dependant approach



Impact assessment level

Implications



Key messages and recommendations

a) The **life cycle based balance of biogenic carbon** contained in construction products, building elements and buildings shall be **net zero**.

b) When construction materials are **recycled or landfilled at the end of life,** an amount of **biogenic CO_2 emissions** equivalent to the biogenic carbon content **shall be accounted for**. Biogenic CO2 safely and permanently removed and stored shall be treated differently.

c) If an existing building is replaced by a new one, the **biogenic carbon stored in the existing building** and the subsequent **release of biogenic CO_2 shall be taken into account**.

d) Natural flows of biogenic carbon in **forests and on agricultural land** (not in harvested products) shall be **disregarded** in buildings LCA.

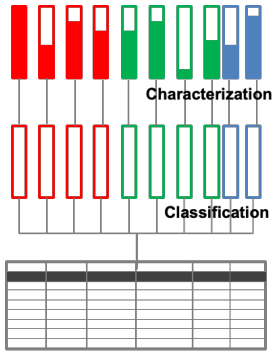
e) The absorption of CO_2 shall **not be accounted for**, if the wood stems from **forests which sold CO_2-emission certificates**

Inventory level

Key messages and recommendations

a) If opting for time-dependent, the time horizon shall at least be set to **100 years plus the final year of the reference study period** (let's say, 50 or 60 years after the construction).

b) Renewable materials used in building elements and buildings store biogenic carbon temporarily. The **temporary biogenic carbon storage has hardly any effects on the overall cumulative radiative forcing** nor on the overall temperature increase. However, it offers a few decades of time to develop technologies o remove and permanently store (biogenic) carbon contained in buildings.

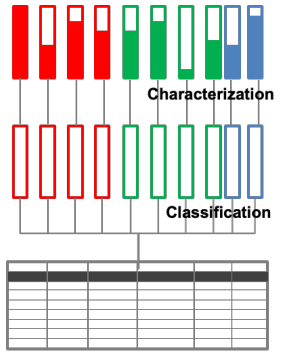


Impact assessment level

Key messages and recommendations

a) While annual CO_2 budgets were discussed in the past, **global total budgets** are considered relevant today. Hence, the **time of release of a ton of CO_2 does not matter and has hardly an influence on its ultimate effect on the longterm rise of global mean surface temperature** (which should not exceed 1.5 °C). Hence, the GWP of an emission of CO_2 shall be independent of time and equal 1 kg $CO_{2\text{-eq}}$ per kg.

b) The **integration time** used to determine the GWP applies **independently of the time of release of CO_2 and other greenhouse gases**. The integration time on one hand and the reference study period and the lifetime of a building on the other are fully independent. A fixed time horizon (of e.g. 100 years) shall not be reasoned with the (fixed) integration time used to determine GWP and GTP.



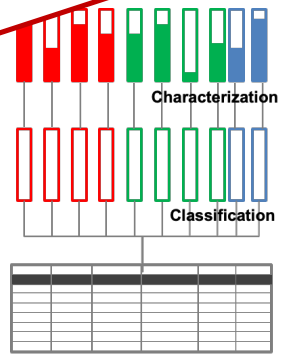
Impact assessment level

Key messages and recommendations

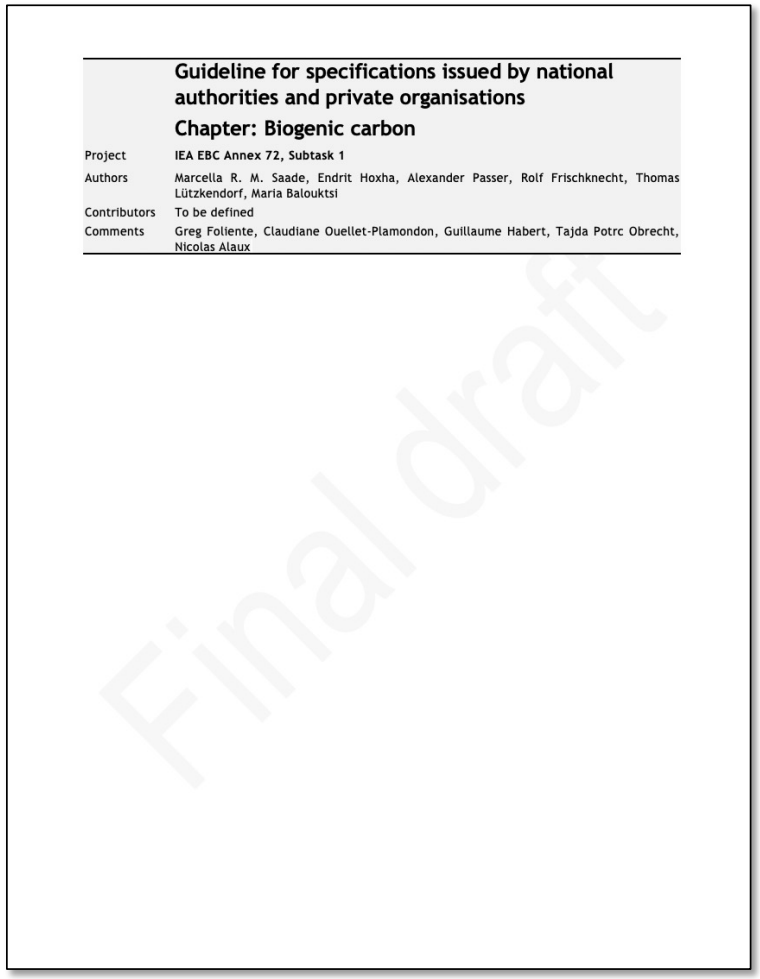
a) While annual CO_2 budgets were discussed in the past, **global total budgets** are considered relevant today. Hence, the **time of release of a ton of CO_2 do not matter and has hardly an influence on its ultimate effect on th rise of global mean surface temperature** (which should no Hence, the GWP of an emission of CO_2 shall be in 1 kg $CO_{2\text{-eq}}$ per kg.

b) The **integration tim the time of r** on c pplies **independently of ouse gases**. The integration time y period and the lifetime of a building on dent. A fixed time horizon (of e.g. 100 years) shall ith the (fixed) integration time used to determine GWP and G

Recommendation: legally binding benchmarks on biogenic carbon content (minimum biogenic carbon content in a building, >XX kg $C_{biogenic}/m^2$)



Impact assessment level



Guideline for specifications issued by national authorities and private organisations

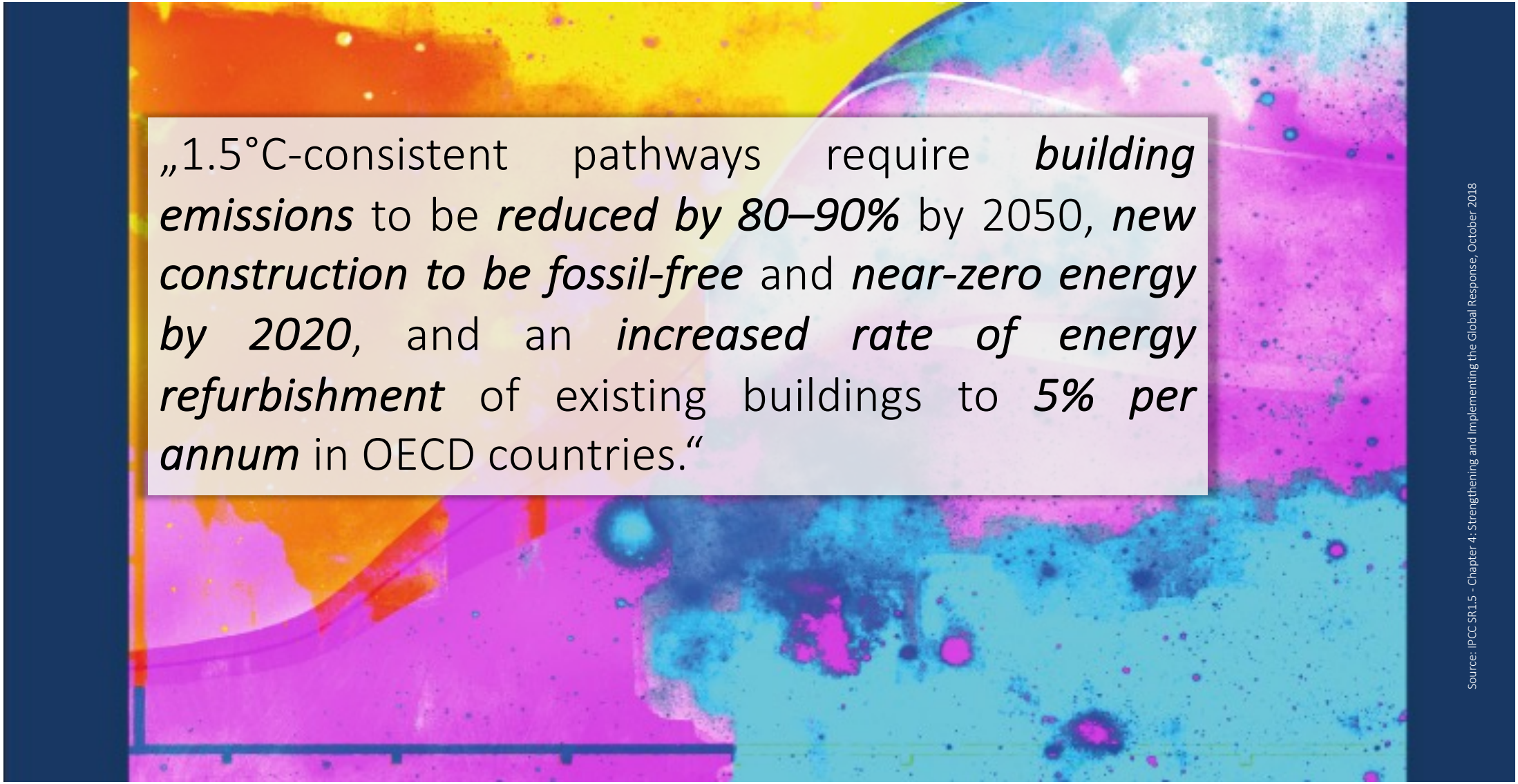
Chapter: Biogenic carbon

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

ANNEX 72

EBC Energy in Buildings and Communities Programme

Final remark from A72: Considering current state of knowledge on time dependent modelling of biogenic carbon in buildings, the scientifically questionable application of a fixed time horizon and the derivation of official IPCC GWP factors, the variability and uncertainty due to choices of important (newly introduced) parameters, and the lack of consensus on the latter, standards and regulations for LCAs of buildings shall rely on fixed characterisation factors and on a net zero biogenic CO_2 balance over the full life cycle (modules A1-C4) unless the biogenic carbon is permanently and safely stored.


„1.5°C-consistent pathways require *building emissions* to be *reduced by 80–90%* by 2050, *new construction to be fossil-free* and *near-zero energy by 2020*, and an *increased rate of energy refurbishment* of existing buildings to *5% per annum* in OECD countries.“
Source: IPCC SR1.5 - Chapter 4: Strengthening and Implementing the Global Response, October 2018

Many thanks & acknowledgement to

Weitere Informationen:
annex72.iea-ebc.org | agnhb.tugraz.at | ite.tugraz.at

Die österreichische Beteiligung am IEA EBC Annex 72 wird im Rahmen der IEA-Forschungskooperation im Auftrag des BMK durchgeführt.

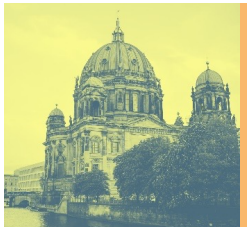
Bundesministerium
Klimaschutz, Umwelt,
Energie, Mobilität,
Innovation und Technologie

IEA RESEARCH COOPERATION

FFG

iea Energy Technology Network

Note on SBE 22 Berlin



sbe berlin 2022

Built Environment within Planetary Boundaries

Sustainable Built Environment D-A-CH Conference 2022

Built Environment within Planetary Boundaries

Sustainable Built Environment D-A-CH Conference 2022

Topics

Resource Management and Material Flows

Climate Neutral Buildings

Post-Fossil Infrastructures

Critical Digitalisation

Socio-Political Frames for Transitions

Open Call For New Topics

sbe22 Contact

Kim Gundlach
team@sbe22.berlin

NATURAL BUILDING LAB - TU Berlin
constructive design and climate adaptive architecture
Straße des 17. Juni 152 I 10623 Berlin

20. - 23. September 2022 Technische Universität Berlin

www.sbe22.berlin

In cooperation with

Partners

Supported by

Diskussion