Climate.now with built environment focus

5 credits

16.5.2023: Carbon storing potential

Dr Jukka Heinonen

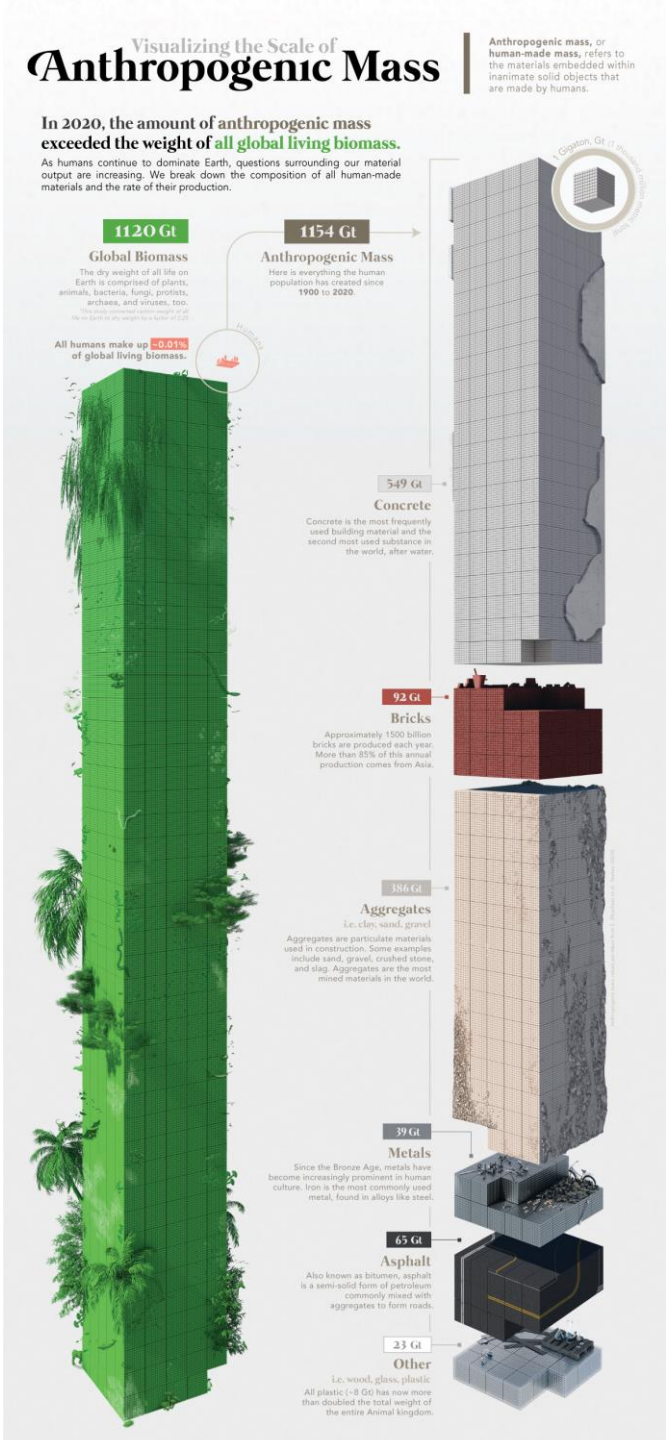
Today’s agenda

- Carbon storage in the urban built environment
  - Carbon-storing alternative materials
  - Carbon storage potential
- Groupwork

IPFA, 2023

In 2020, the amount of anthropogenic mass **exceeded** the weight of all global living biomass

- Concrete
- Bricks
- Aggregates
- Metals
- Asphalt



https://www.visualcapitalist.com/visualizing-the-accumulation-of-human-made-mass-on-earth/

Carbon sequestration vs carbon storage

Carbon sequestration, or uptake, refers to the active process of removing carbon

Carbon storage refers to keeping the carbon contained for a period of time

Increase bio-based construction materials

- Timber, bamboo, straw, hemp
- Living building materials
- Green roofs and walls

Material	CO_2 content (kg CO_2/kg)
Wood	1.84 (1.54-2.24)
Bamboo	2.02-2.46
Straw	1.76
Hemp	2.02-2.09

Living building materials

Ludwig, F., Middleton, W., Gallenmüller, F., Rogers, P., & Speck, T. (2019). Living bridges using aerial roots of ficus elastica – an interdisciplinary perspective. *Scientific Reports*, *9*(1), Article 1. https://doi.org/10.1038/s41598-019-48652-w

Urban green structures - Roofs

Urban green structures - Walls

Urban green structures

Urban/rooftop/vertical farming

Features of green roofs and walls

1. Increased urban biodiversity
   - Significance on the global biodiversity
2. Absorption of CO2
   - The mechanism, how important as a carbon sink?
3. Urban air quality
   - The mechanism, relationship to urban farming and biodiversity
4. Storm water runoff reduction
   - The benefits of slower/reduced storm water runoff
5. Local food production
   - How important is this feature? Is there a trade off between food production and the above gains?
6. Market penetration obstacles
   - Why, despite all the evident positive features, green roofs and walls are as rare as they are?

Wooden construction, as one plant-based material example, causes significantly less emissions than concrete

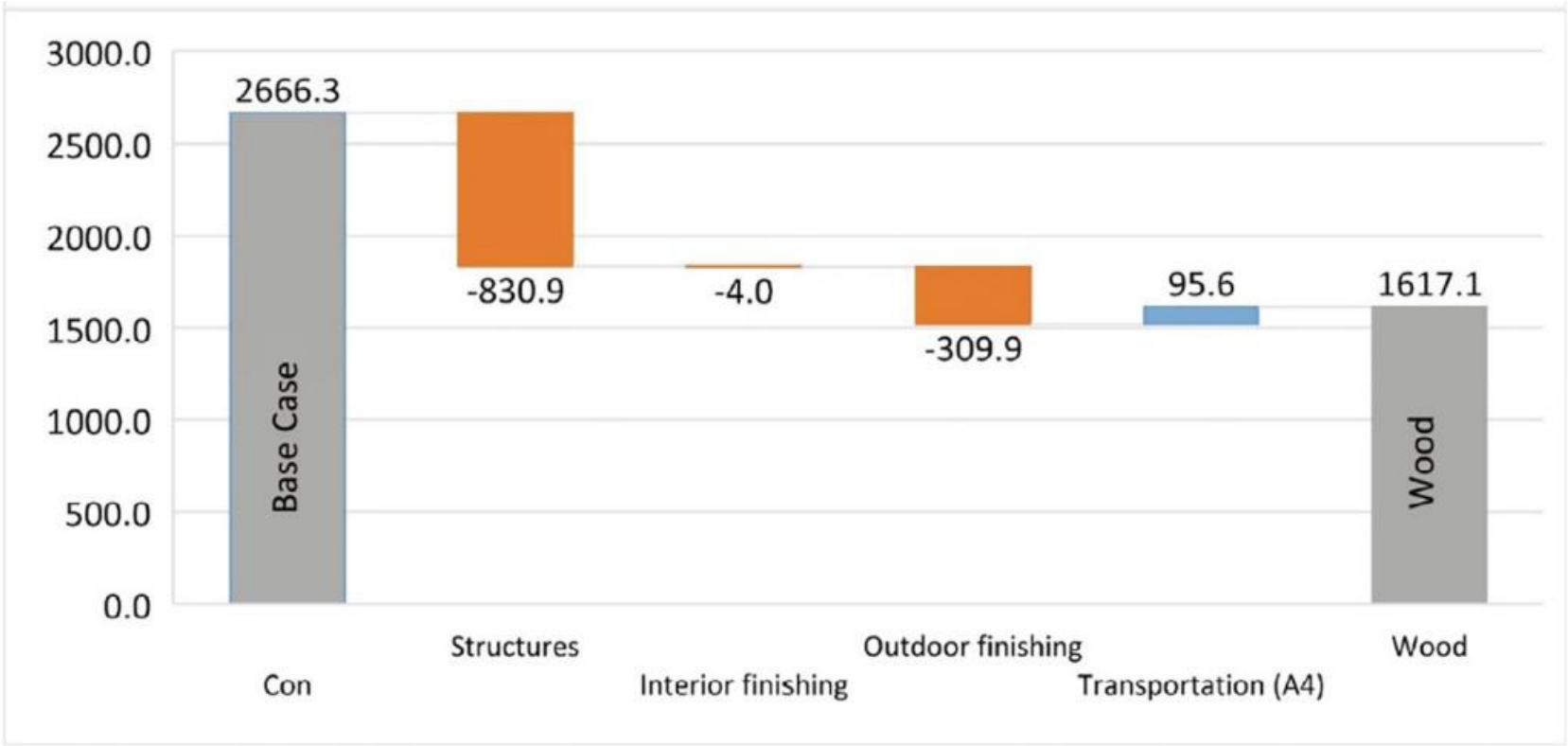


Fig. 5. The contributions of each building system in reducing the climate change impact in three scenarios compared to the base case.

Amiri et al. 2021

When the storage capacity of wood is accounted for, wooden buildings can well store more carbon than was released during its production

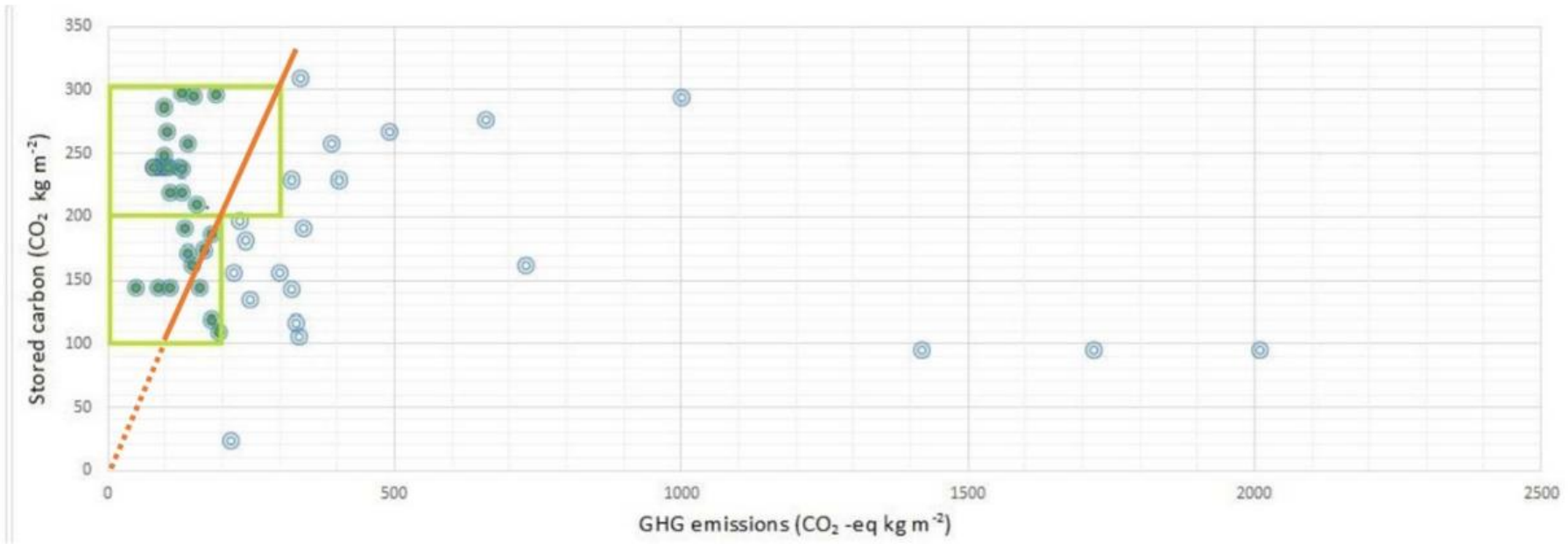
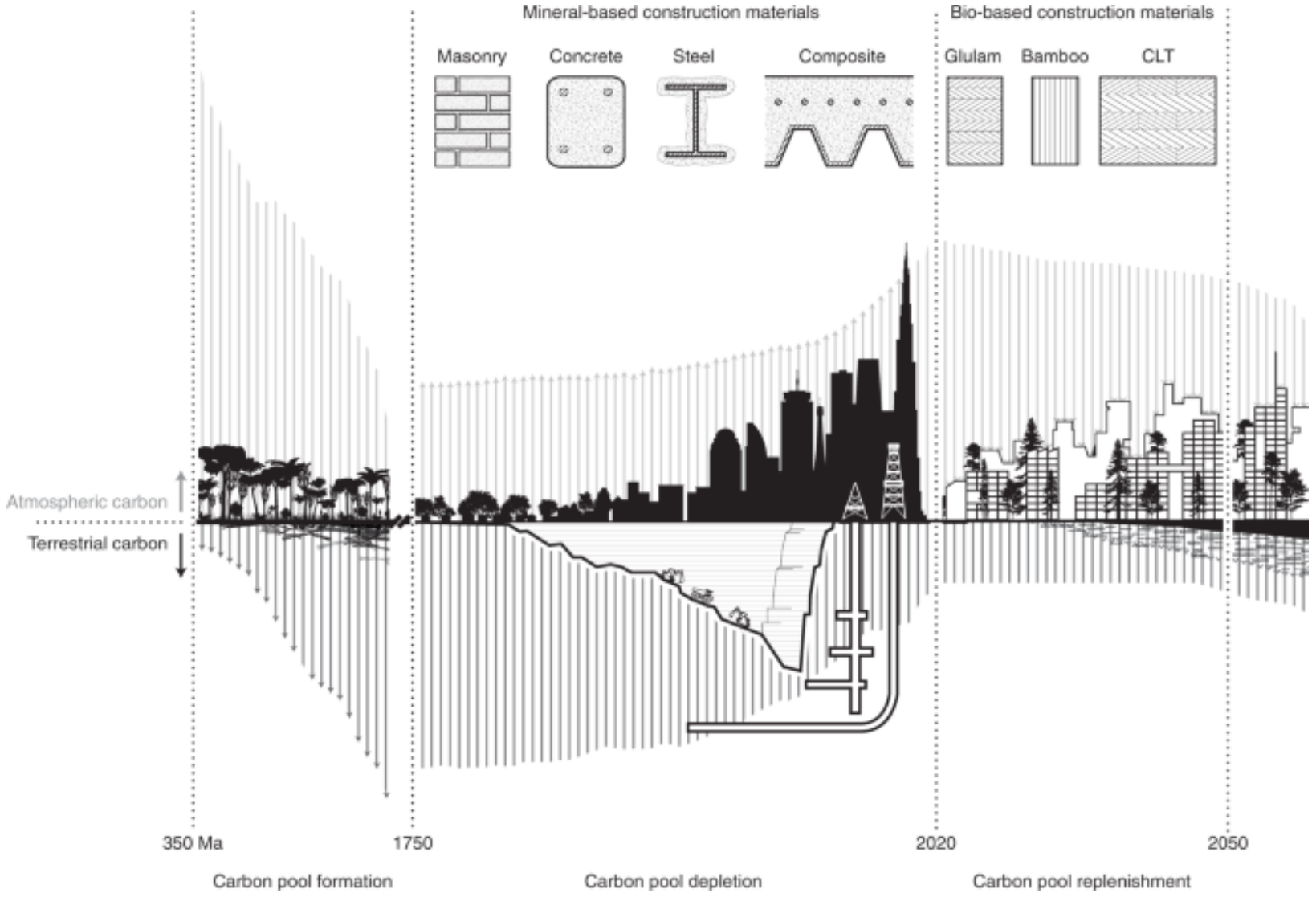


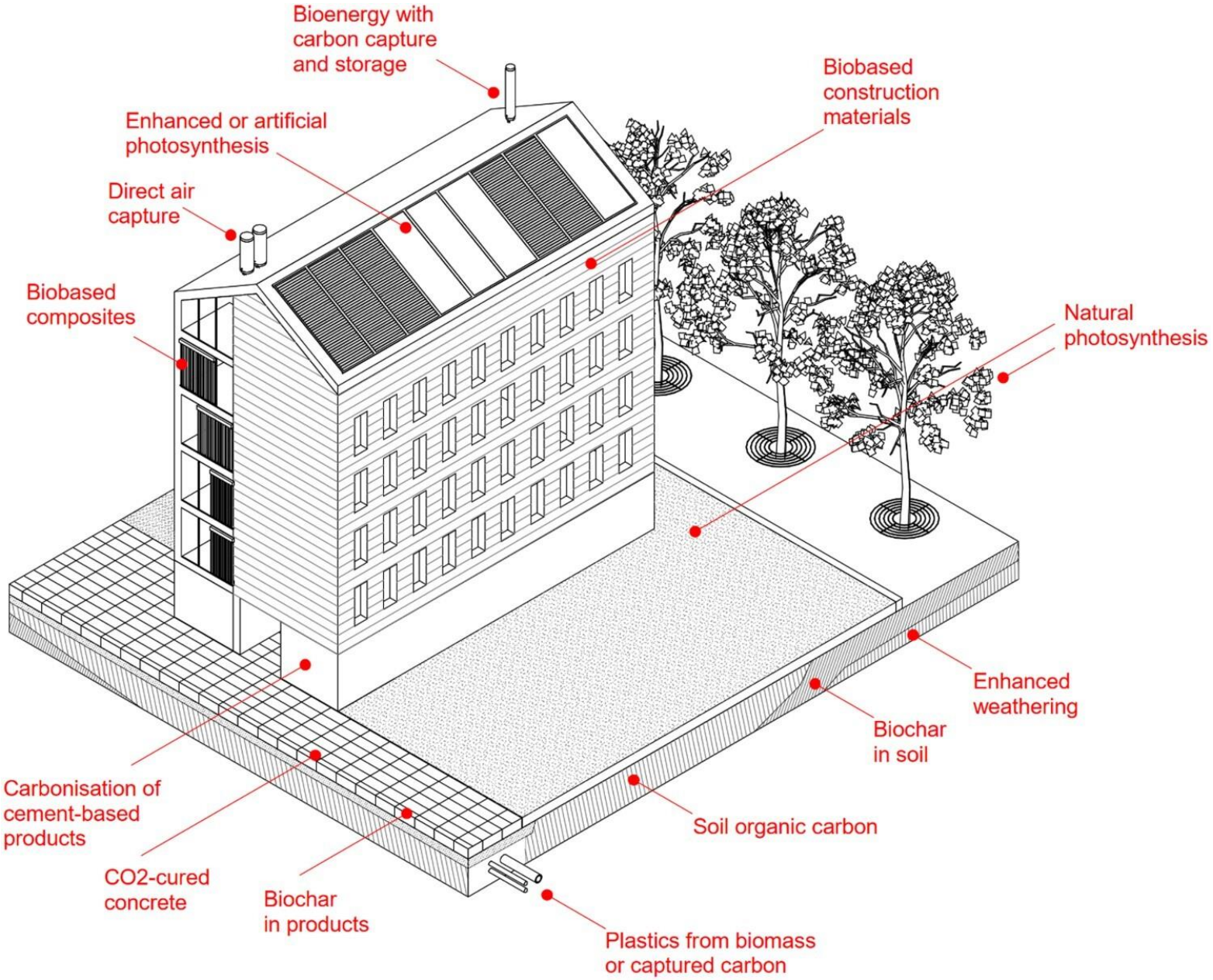
Figure 3. CO_2 emissions vs. CO_2 capture.

Carbon storage potential in timber construction

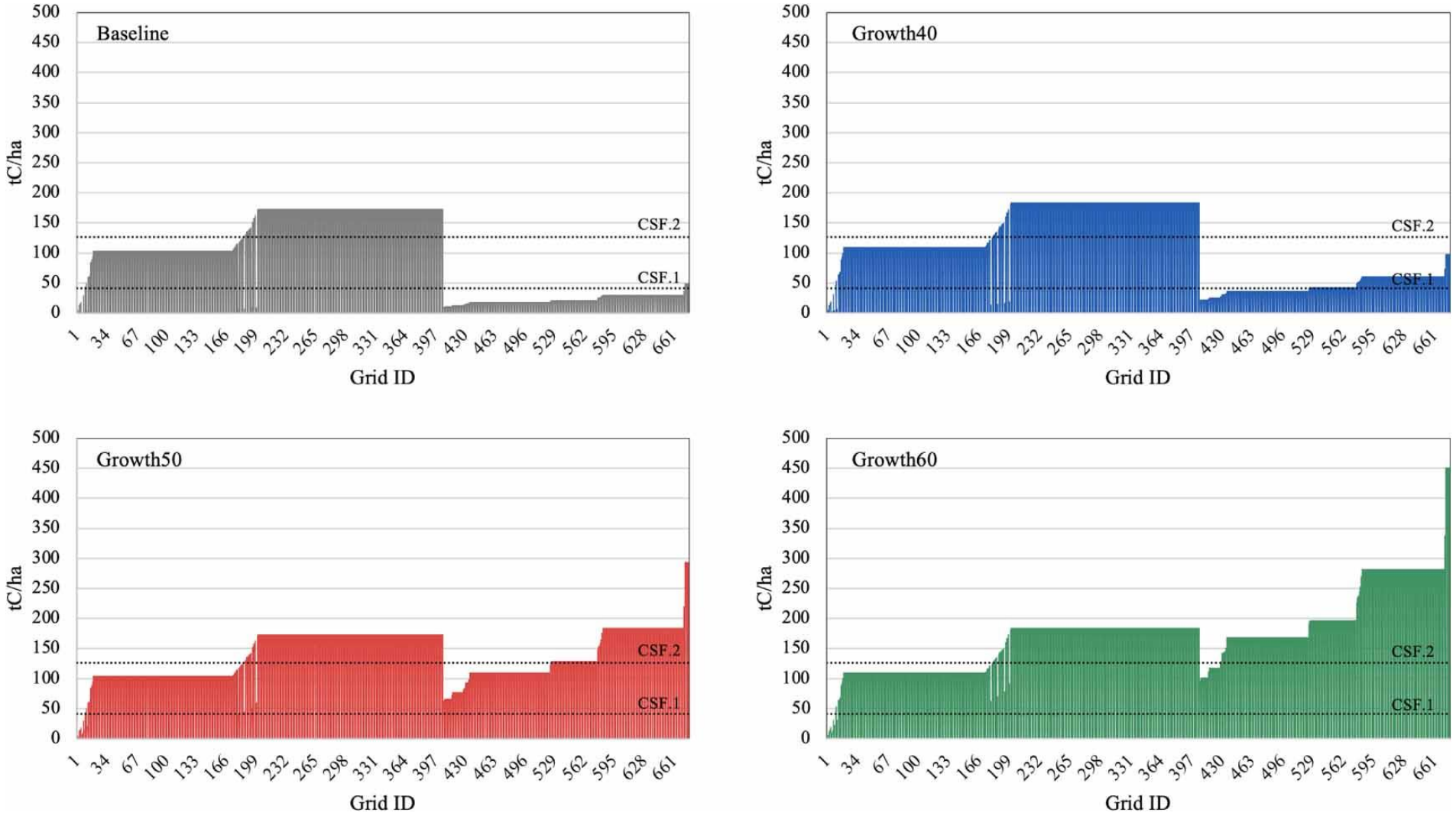
- Hildebrandt et al. (2017) estimated the European building sector has an achievable potential for net carbon storage of about 0.046 Gt CO2 per year in 2030
- Churkina et al. (2020) estimated the construction of timber buildings for new urban dwellers globally could store 0.01–0.68 Gt CO2 per year
- Global annual CO2 emissions = 38 Gt CO2 per year



Churkina, G., Organschi, A., Reyer, C.P.O. *et al.* Buildings as a global carbon sink. *Nat Sustain* **3**, 269–276 (2020). https://doi.org/10.1038/s41893-019-0462-4



Matti Kuittinen, Caya Zernicke, Simon Slabik & Annette Hafner (2023) How can carbon be stored in the built environment? A review of potential options, Architectural Science Review, 66:2, 91-107, DOI: 10.1080/00038628.2021.1896471



Ilmari Talvitie, Antti Kinnunen, Ali Amiri1 and Seppo Junnila. (2023) Can future cities grow a carbon storage equal to forests? Environ. Res. Lett. 18 044029. DOI 10.1088/1748-9326/acc677

It is possible to go even beyond the carbon storage of a forest

LETTER • OPEN ACCESS

Can future cities grow a carbon storage equal to forests?

Ilmari Talvitie[2,1], Antti Kinnunen[1], Ali Amiri[1] and Seppo Junnila[1]

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Remember the global perspective

- **Natural environment is the main source of biodiversity**
  - Increasing the built environment (e.g. within-city) biodiversity is predominantly a positive target, but in general does not replace biodiversity loss due to shrinking and degrading natural environment
  - Thus, no matter the development with the within-city biodiversity, global biodiversity conservation should not be overlooked

- Just like (virtually) **all our activities requiring material inputs cause GHG emissions somewhere**, they cause harm to the wildlife somewhere
- Very difficult to measure robustly, but should not be overlooked or omitted from ecological impact analyses
- We thus should also understand what is needed to build our ”green city”

Group exercise

1. Mycelium
2. Hempcrete
3. CLT
4. Bamboo
5. Biocrete
6. Biocement
7. Bioasphalt
8. Living building
9. Urban “carbon farming”

Try to find answers to the following:

Carbon balance
What is the carbon content? (-)
What are the production emissions? (+)
What is the carbon storage potential? (=)

Market potential

Current market status

Future prospects

Be aware of the functional units

Be prepared to present you findings

Upcoming lectures

- 23.05 – Circular Construction
  - Dr Katarzyna Jagodzinska (online)
- 01.06 – Density and low-carbon illusion – on Thursday!!
  - Dr Jukka Heinonen (in person)