**Context**

Ecosystem Crises require Earth System Stewardship

- Global agreement: World agreed to tackle the climate crisis 
- Earth System Stewardship: We aim for reducing GHG emissions to net zero term, ‘Stabilised Earth’.

**Research questions**

1. What are the environmental targets for ‘buildings’ during transition and long-term?
   - How can we define environmental budgets for buildings based on top-down targets?
   - What are the environmental budgets for buildings and building stocks?

2. Which building design features and strategies enable meeting environmental targets?
   - Which design strategies and features provide environmental benefits in current building practice?
   - How can technological and social innovation further improve environmental performance?

3. How can we use the findings to test scenarios for building stock development within environmental limits?
   - How can we use the environmental data of buildings for modelling building stock development scenarios?
   - What are the environmental synergies and trade-offs when applying promising building design strategies at macro-scale?

**Results**

Meta-study: Embodied GHG emissions: The hidden challenge for effective climate change mitigation [Röck et al. 2020]

- Method
  - Systematic analysis of >500 building LCA cases, synthesis from 318 building results, harmonized (per m²GFA, RSP 30 years), categorized (by energy performance).

- Findings
  - Life cycle GHG emissions have reduced due to energy efficiency improvements. Meanwhile, embodied GHG emissions increased, now dominating the life cycle (xw%)
  - Upfront embodied GHG emissions lead to carbon spike (material production) and dominate the first ~30 years (timeframe for effective climate change mitigation) (w%)
  - Optimisation of full building life cycle is required to achieve net-zero GHG emissions within carbon budgets (xw%).

Synthesis: Carbon budgets for buildings: harmonising temporal, spatial and sectoral dimensions [Habert et al. 2020]

- Context
  - Target values for creating carbon budgets for buildings are important for developing climate-neutral building stocks.

- Findings
  - A framework is proposed to accommodate these different perspectives and spatio-temporal scales towards harmonised and comparable cross-sectoral budget definitions (see F1).
    - This analysis highlights the crucial need to define the temporal scale, the roles of buildings as physical artefacts and their economic activities (saw%)
    - This will assist regulators and building design decision makers to coordinate and incorporate their specific responsibility at different levels or scale of activity to ensure overall coherence.

**Outlook**

Next steps in this research will be:

1. Life cycle assessment (LCA) of building case studies
2. Technological innovation: Analysis of environmental potentials of buildings and building elements using bio-based or regenerative materials or innovative building energy concepts
3. Social innovation: Analysing potentials for increasing occupational density through innovative building typologies

**References**


[R5] Rock, M. Ruschi Mendes Saade, M. Balouktsi, F. Nygaard Rasmussen, H. & Dr. Alexander Passer. Embodied GHG emissions lead to carbon spike within life cycle of buildings, for different building types, differences by energy-performance class. [https://doi.org/10.1126/science.281.5374.190](https://doi.org/10.1126/science.281.5374.190)

**PUBLICATIONS**


**BUILDING FUTURE(S)**

Environmental modelling of buildings and building stock dynamics for supporting active development within environmental boundaries

**Development within the Safe Operating Space**

- It is a global challenge to adapt to climate change effects while at the same time staying within GHG emission budgets.

- Beyond GHG emissions, it is important to consider wider environmental implications, e.g., Planetary Boundaries.

- Challenge: To enable transition and long-term development of human societies within the ‘safe operating space’.

**Buildings and Construction to transition to Net-Zero**

- Construction and operation of buildings account for ~40% of global GHG emissions.

- Target: ‘Net-zero’ GHG emissions across the full building life cycle (construction and operation).

- Challenge: Ensure transition to net-zero and long-term development within safe operating space for both new and existing buildings (stocks).

**Next steps**

1. Life cycle assessment (LCA) of building case studies
2. Technological innovation: Analysis of environmental potentials of buildings and building elements using bio-based or regenerative materials or innovative building energy concepts
3. Social innovation: Analysing potentials for increasing occupational density through innovative building typologies

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