

Integration of climate change in life cycle assessment during the use phase of buildings

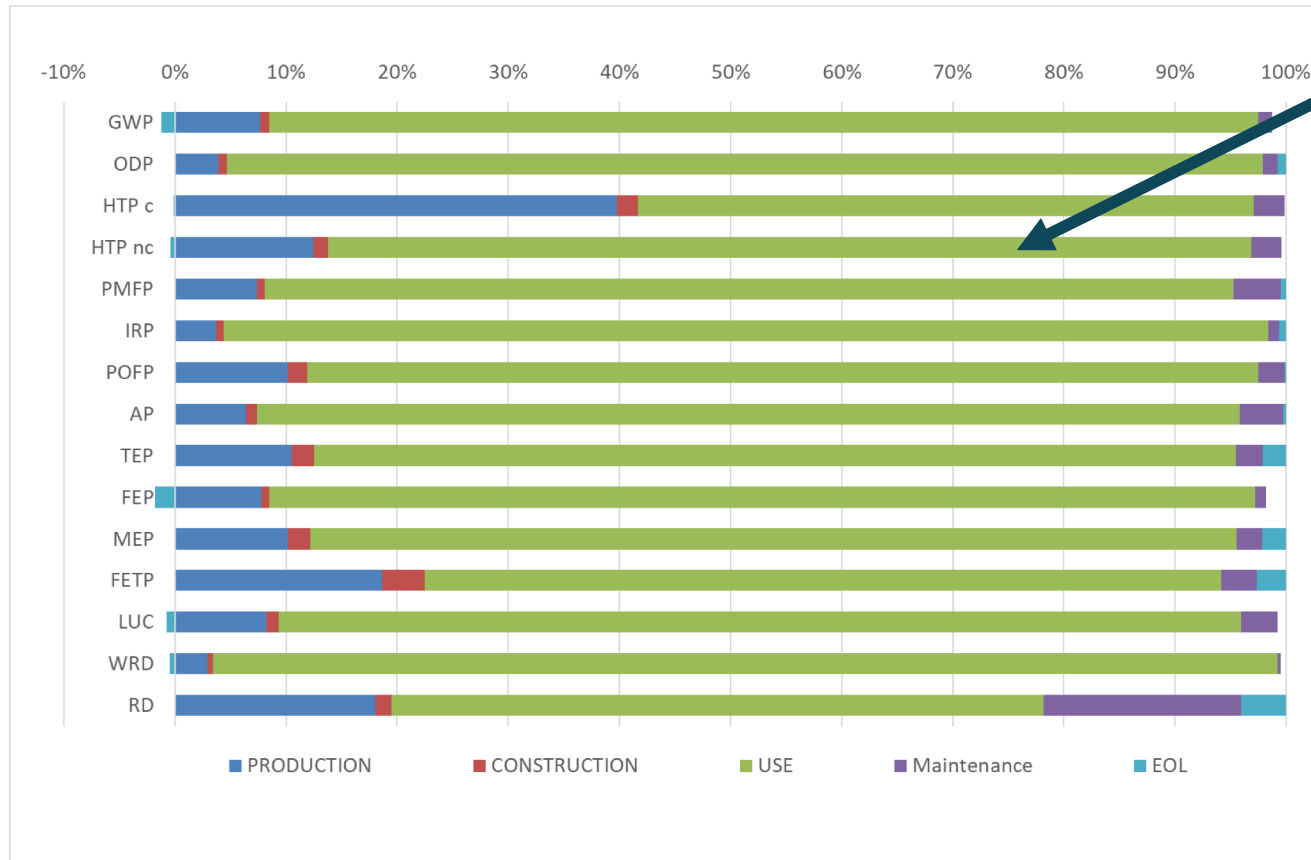
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SBE19 Graz

September 11th-14th, Graz

Context



Influenced by:

- Technologies
- Energy mix
- Policy
- Climate conditions
- ...

Baseline scenario: contributions of life cycle phases to the life cycle impact [Baldassarri et al. 2017]

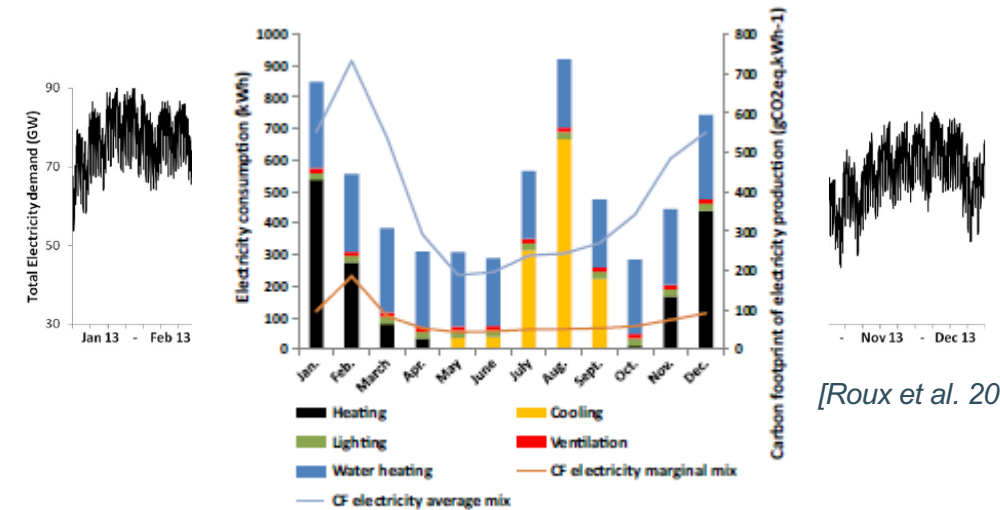


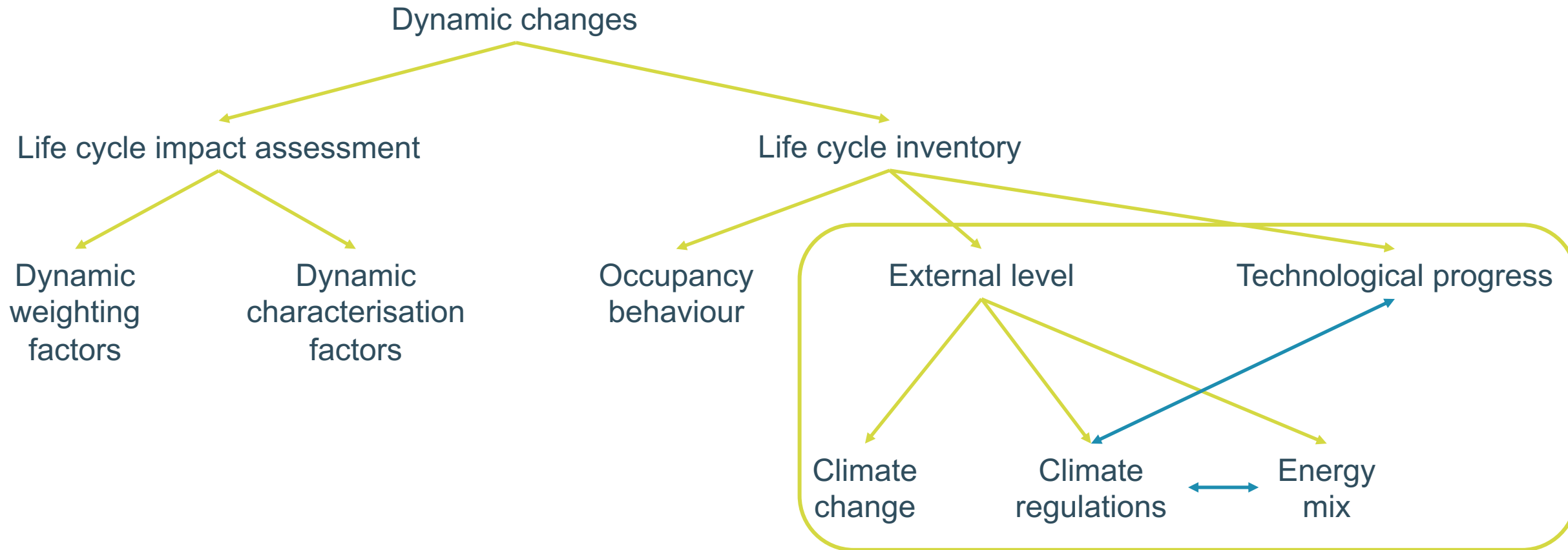
Fig. 9. Monthly electricity consumption of the house and carbon footprint (CF) of the electricity mixes, for scenario 1B, long-term horizon (2045–2065).

[Roux et al. 2016]

Dynamic LCA

“an approach to LCA which explicitly incorporates dynamic process modelling in the context of temporal and spatial variations in the surrounding industrial and environmental systems” [Collinge et al., 2013]

Dynamic LCA



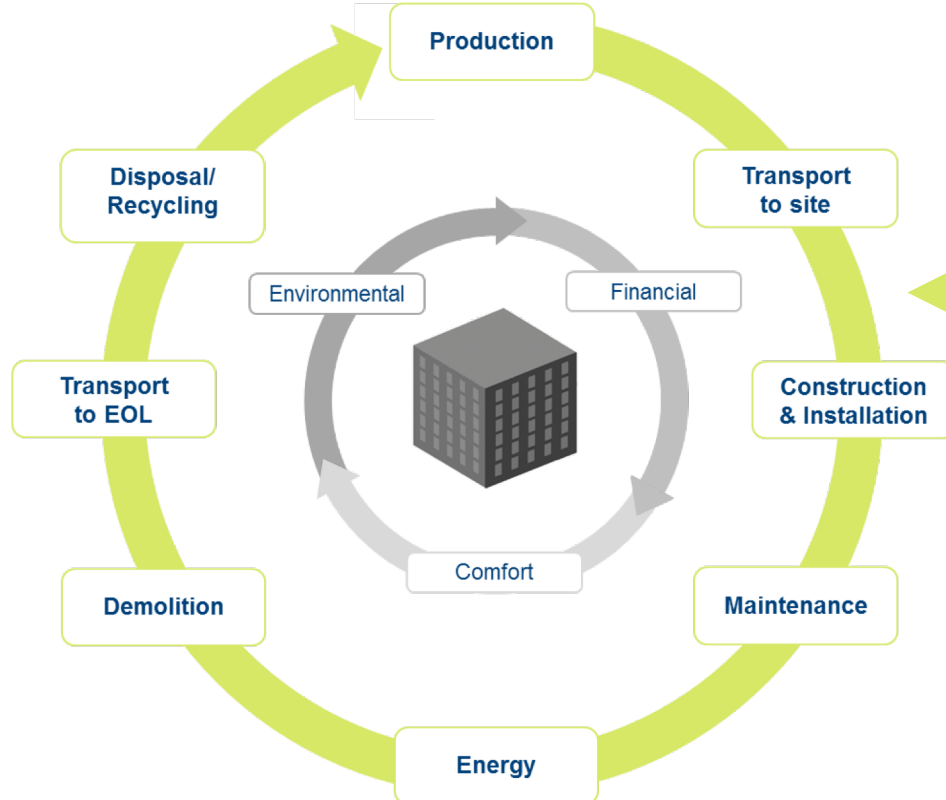
Based on Collinge et al. (2013), Su et al. (2017) and Negishi et al. (2018)

PhD research

Integrated Life Cycle & Climate modelling

Life Cycle modelling

MMG+_KU Leuven Tool + comfort assessment

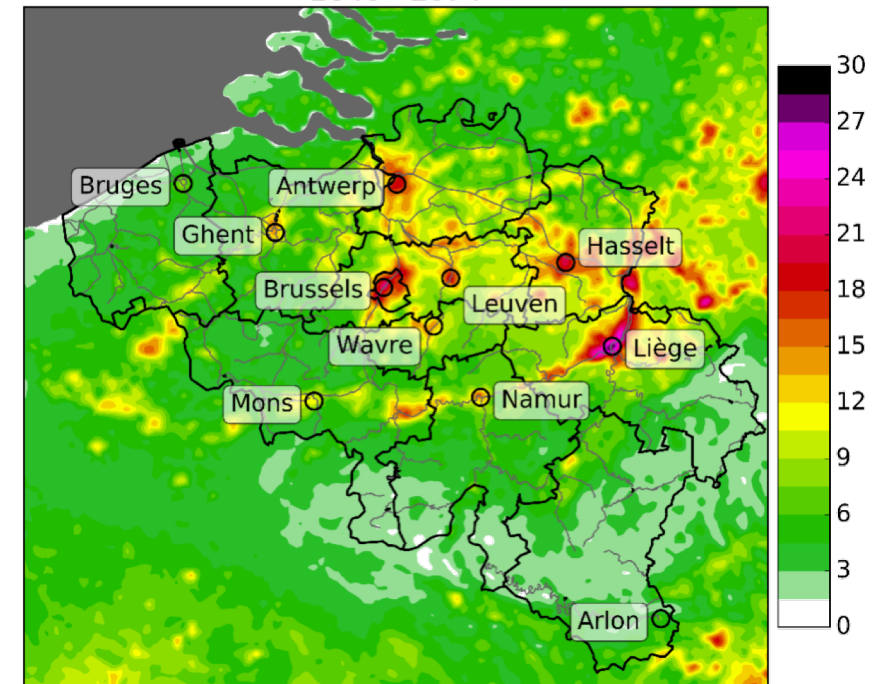


@ Architectural Engineering

Climate modelling

Convection-permitting climate model data for Flanders

2040 - 2074



@ Regional Climate Studies

Goal & scope

- 1) To what extent is climate change currently taken into account?
- 2) How can climate change be integrated in the life cycle modelling framework?
 - changes in operational energy use due to climate change
 - changes in operational energy use due to technological evolution or climate regulations
 - changes in energy mix (increase of renewable energy) due to climate regulations

Based on a literature review (± 30 papers reviewed)

Literature review - highlights

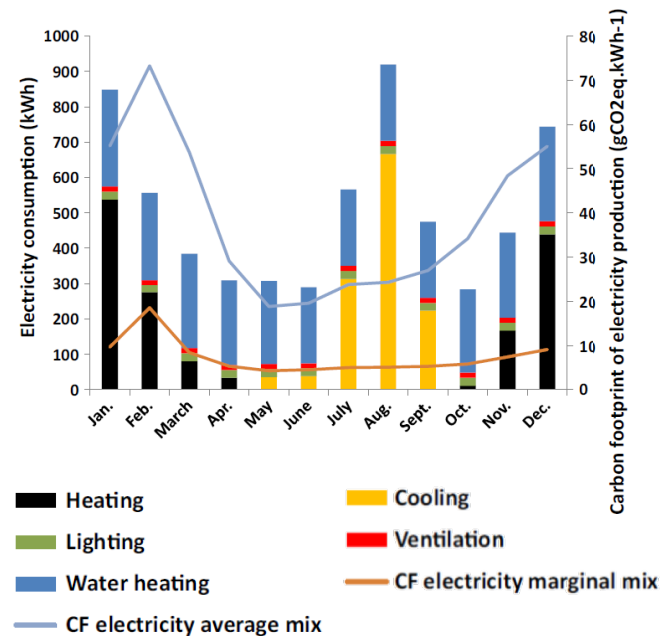
- Heating demand ↓ & cooling demand ↑
- Change in total demand
 - ~ climate change scenario
 - ~ region
 - ~ time frame
- Importance of electricity
- Importance of cooling system efficiency

Literature review - Discussion

- Time step
- Holistic approach
- Uncertainties

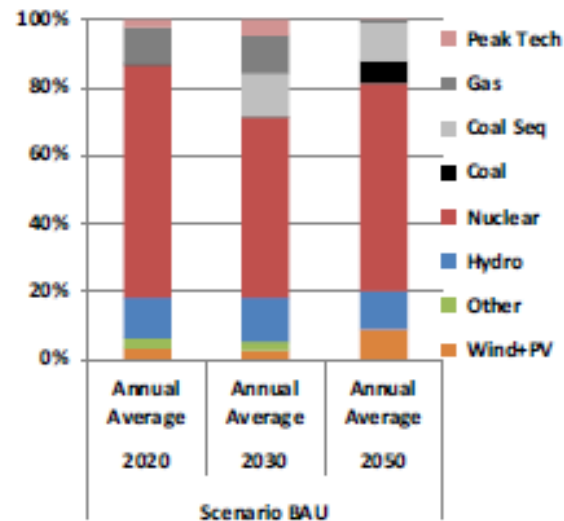
Discussion – Time steps

Short-term



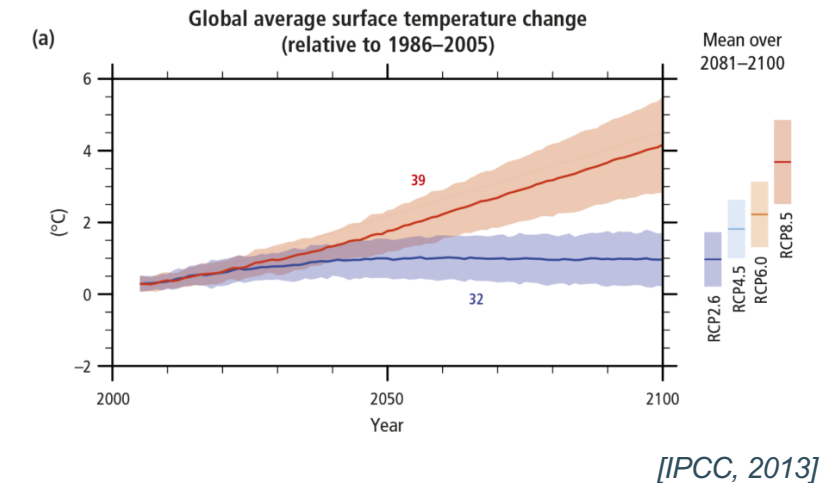
[Roux, C. et al, 2016]

Mid-term



[Roux, C. et al, 2016]

Long-term



[IPCC, 2013]

Discussion – Time steps

Multiple time periods

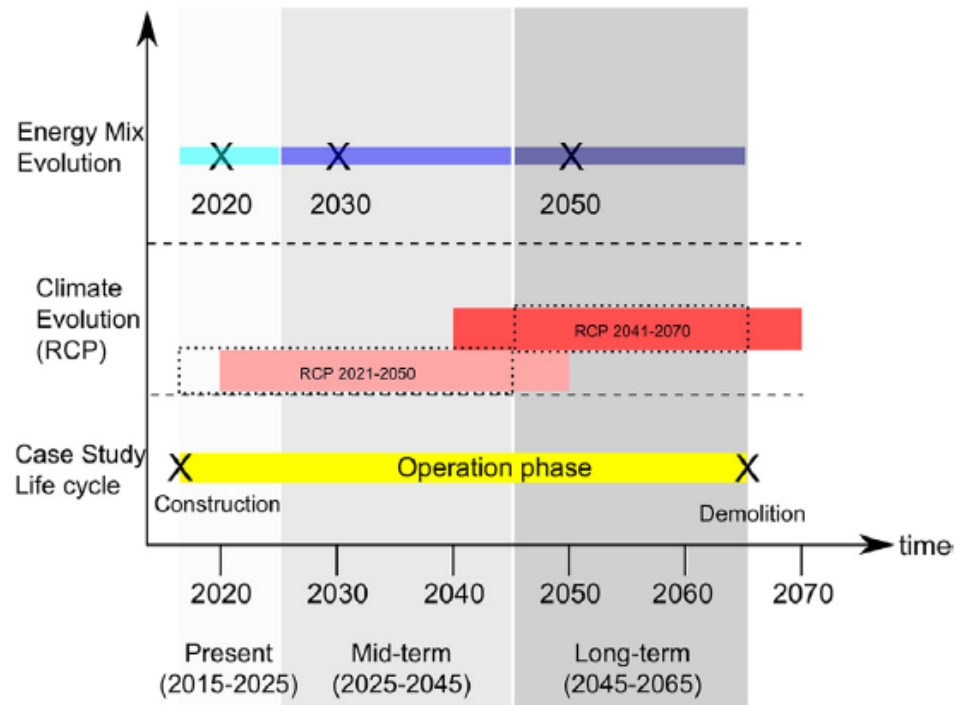


Fig. 1. Life cycle timeframe of the case study.

[Roux et al. 2016]

Year by year evolution

Discussion – Holistic approach

➤ Importance electricity

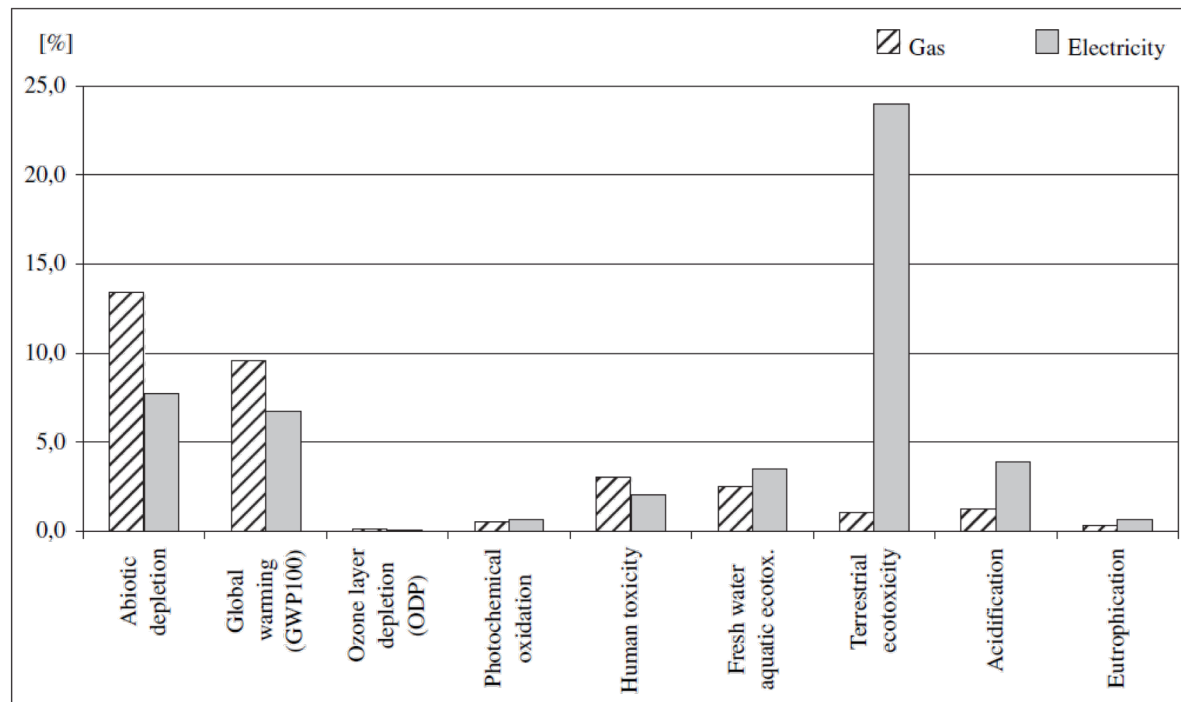
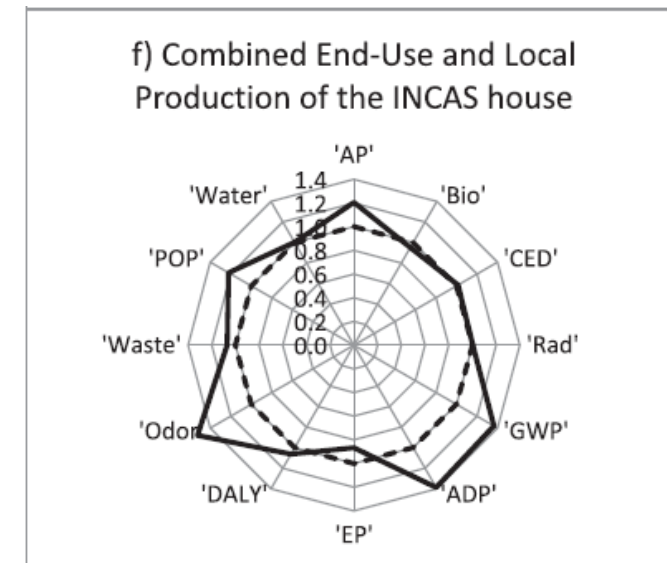


Fig. 7. Normalised environmental impact of total annual residential gas and electricity consumption in the Netherlands.
[Blom et al. 2011]

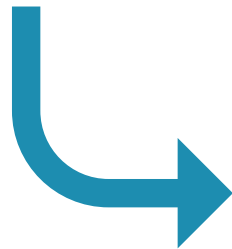


Comparison impact assessment hourly mix (plain line) and yearly average mix (dotted line)

[Roux et al. 2015]

Discussion – Uncertainties

- #Scenarios
 - Climate change
 - Energy mix
 - Technological evolutions
- Linear vs. non-linear change towards scenario
 - Goal



Sensitivity analysis

- Best & worst case scenario

Conclusion literature review

- Dynamic changes in operational energy use & related impacts of a building
 - Climate change
 - Technological evolutions
 - Energy mix
- Influence depending on
 - Region
 - Time frame
 - Environmental impact indicator
- Recommended
 - Time step
 - Holistic approach
 - Sensitivity analysis

Thanks!
Questions or comments?