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

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Context

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

Influenced by:
- Technologies
- Energy mix
- Policy
- Climate conditions
- …
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
- Disposal/Recycling
- Transport to site
- Environmental
- Financial
- Construction & Installation
- Comfort
- Maintenance
- Energy

@ 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

Mid-term

Long-term

[Roux, C. et al, 2016]

[Roux, C. et al, 2016]

[IPCC, 2013]
Multiple time periods

Year by year evolution

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

[Roux et al. 2016]
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?

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