

INTRODUCTION AND RESEARCH QUESTIONS

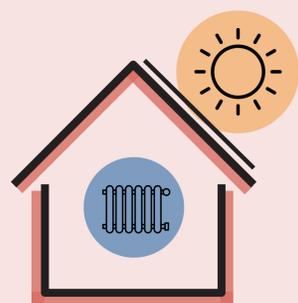
Embodied emissions are becoming dominant over the building lifecycle. A **holistic approach** that evaluates embodied and operational emissions must be, therefore, adopted.

This research **integrates** life cycle impact assessment (with a focus on CO₂e assessment) with building energy simulation to evaluate the **whole-life carbon** performance of residential building renovations. It aims to understand: which **variables** affect the life cycle environmental performance of building renovation, how **climate change** and **electricity mix** influence the transition from Zero Energy to Zero Carbon buildings, what is the **optimal order and combination** of renovation interventions under economic constraints, and across different climatic and electricity mix scenarios?



METHODOLOGY

Parametrization of renovation scenarios



Renewables
Envelope & Materials
Systems

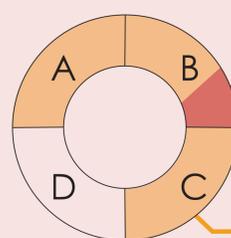
Low Energy



Ultra-Low Energy



Life cycle impact assessment & Building performance simulation



Operational emissions (B6)

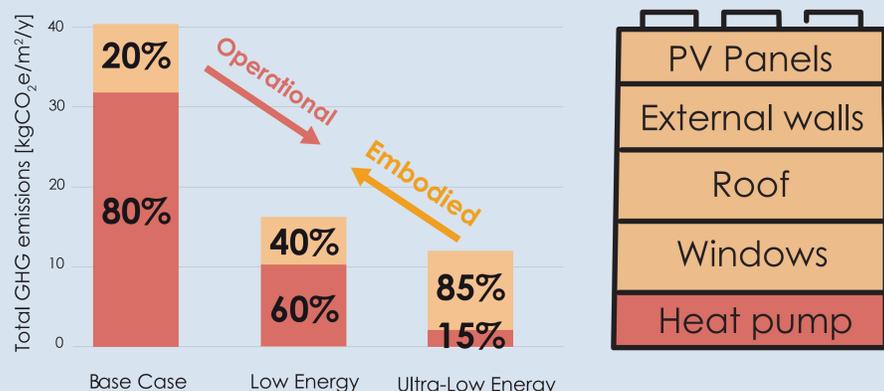
including:
climate change projections
hourly electricity mix
electricity mix projections

Embodied emissions (Stages A1-A5, B4, C3-C4)

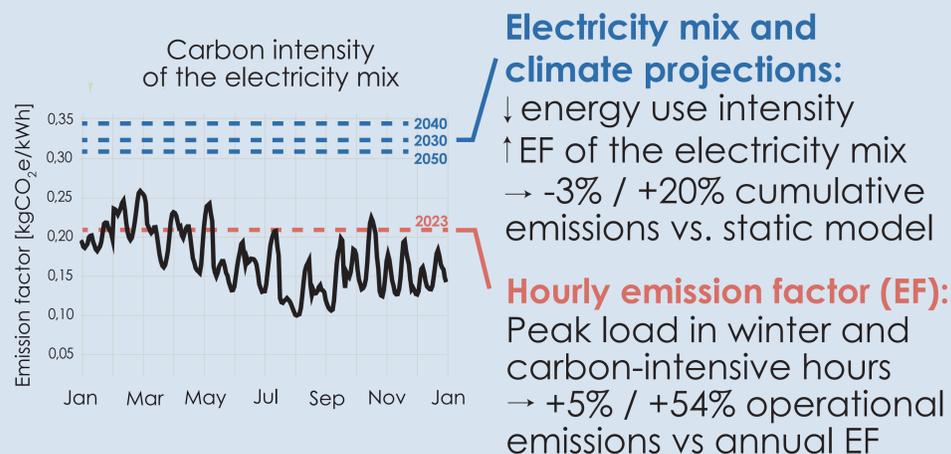
Sensitivity analysis

RESULTS

Total GHG emissions [kgCO₂e/m²/y]



Dynamic vs static modeling approach



CONCLUSION AND FUTURE STEPS

- Bio-based materials should be preferred to petrochemical materials to limit the embodied emissions.
 - Accounting for hourly EF, climate, and electricity mix variations avoids major GHG estimation errors.
- Next steps:** emissions optimization accounting for evolving carbon taxes, energy/product prices, and subsidies over time, tailored to the Belgian context and typical dwelling archetypes based on local layouts and technical solutions.

Full paper here!

