# Modelling Occupant Thermal Comfort and Overheating Risks in Residential Buildings


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## ABSTRACT


- Impacts of Overheating resulted from global warming on indoor environment leads to socioeconomic damages, thermal discomfort, productivity reduction, and in severe cases to illness and death.
- Designing resistant buildings and renovating the existing ones are the solutions for reducing the overheating impacts.
- Four historical and future climatic scenarios is be used to perform BES-CFD-BEHAM followed by real-time monitoring.


## KEYWORDS


Adaptation measures, Building classification, BES, Socioeconomic, Resilience, CFD, IAQ, Belgium


## PROBLEM

1. According to IPCC fifth assessment report (AR5), the global mean temperature will increase during the 21st century. And, the extreme short-term events such as heatwaves will be more frequent and severe.
2. High outdoor temperatures will significantly affect the indoor thermal conditions and will lead to essential indoor overheating incidents that deteriorates occupants' comfort, productivity, and health.
3. During the summer 2003. approximately 1175 people died in Belgium, mostly because of respiratory and cardiovascular issues triggered by overheating.
4. Socioeconomically deprived occupants who cannot afford adequate cooling or adaptation measures are at higher risk

## OBJECTIVES / HYPOTHESIS

- ✓ Identifying the climate change sensitive overheating indicators and criteria
- ✓ Establishing benchmark buildings for Walloon region.
- ✓ Monitoring the trend of indoor and outdoor environmental parameters
- ✓ Developing a novel method for the integration of BES and CFD numerical modellings
- ✓ Showing the future climate projections under multiple scenarios and overheating health risks for the community along with prioritizing the adaptation measures
- ✓ Assessment of future direct and indirect socioeconomic damage and risk of different climatic scenarios for the Walloon region.

## AUDIENCE

Policymakers, scientists, health services, housing corporations, building engineers, architects, and energy companies.

## RESEARCH QUESTIONS

- ➢ What is overheating and how to define short-term and long-term overheating phenomena?
- ➢ What is the dominant residential building typology in Walloon region?
- ➢ What is the trend of real indoor environmental parameters during a year?
- ➢ How CFD and BES simulations can be integrated to achieve reliable and detailed modelling of indoor and outdoor thermal environments?
- ➢ How to make the community to be aware of the impacts of climate change and associated health risks? How to provide solutions for the community to deal with the overheating risks?
- ➢ What will be the socioeconomic consequences of climate change and air-conditioning on the building stock, and what will be the effect of building adaptation (rebound effect) measures?

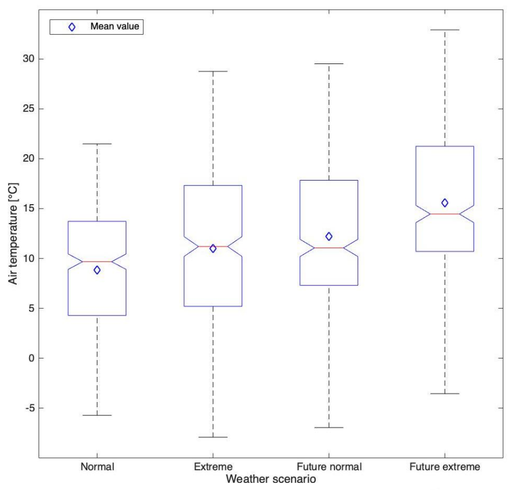
## ORIGINALITY

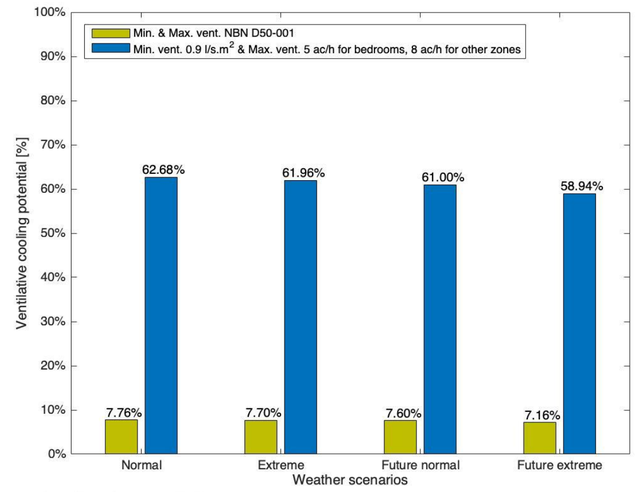
A novel method for dynamic coupling of the CFD and BES is developed for the indoor environment at initial stage. Subsequently, it is extended to integrate the outdoor and indoor environments through the building envelope.

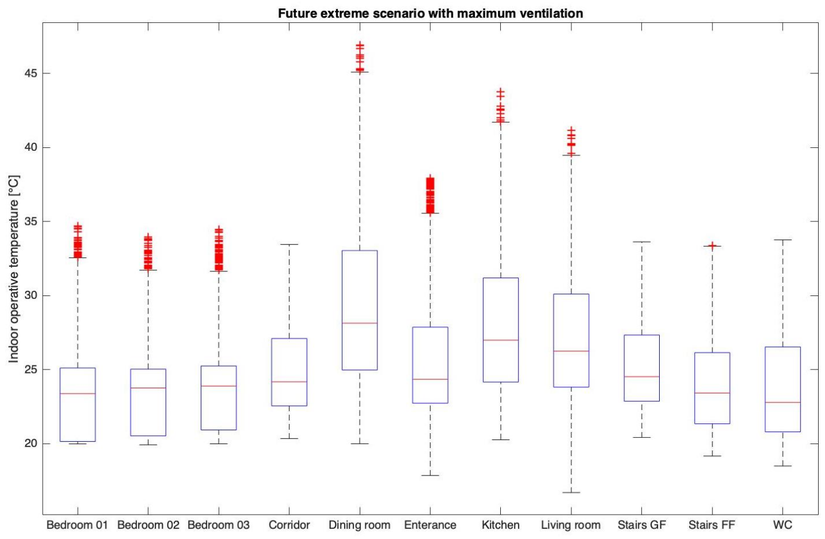
## METHODOLOGY

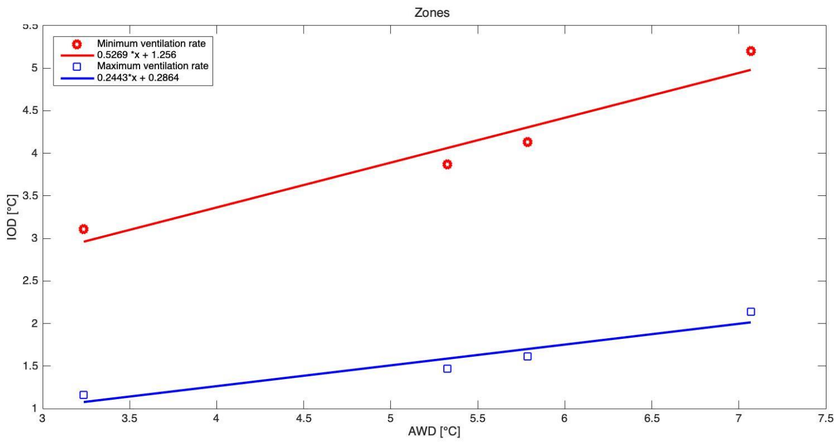
An intensive literature review is conduced on the state-of-the-art overheating assessment methods. Benchmark models representing the Belgian residential building stock are developed. In parallel to the monitoring campaign on the benchmark buildings, the selected overheating assessment method is applied by post-processing the results of building numerical modellings. The performance of multiple adaptation measures and cooling technologies is evaluated as well. At the final stage, the socioeconomic direct and indirect impact of different future climate scenarios is assessed.

## RESULTS




## CONCLUSION

This project sheds light on the importance of the climate resilience design. The integrated multi-domain numerical modelling validated through the long-term monitoring enables to predict the performance of buildings in the future climates. The resilient cooling technologies and adaptation measures are studied, applied, evaluated, and ranked. The community informed about the possible solutions to mitigate the overheating and associated health risks. This research is a reliable source for the policy makers at local, provincial, regional governments in decision making for the national building norms.

## RESOURCES


*[1] Hamdy, M., Carlucci, S., Hoes, P., & Hensen, J. L. M. (2017). The impact of climate change on the overheating risk in dwellings: A Dutch case study. Building and Environment, 122(August 2003), 307–323. https://doi.org/10.1016/j.buildenv.2017.06.031*

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