ReCOver++ project: wrap up

Hilde Breesch[1], Douaa Al Assaad[1,2], Abantika Sengupta[1,3], Marijke Steeman[3]

1 KU Leuven
9000 Gent, Belgium

2 TU Eindhoven
5600 MB Eindhoven, The Netherlands

3 Ghent University, 9000 Gent, Belgium

SUMMARY

The increasing severity and duration of climate change is that extremes – notably heatwaves, increases the risk of human thermal stress in indoor environments where people spend most of their times. Recent field measurements have demonstrated significant overheating in the EU building stock in the EU, characterized by well-insulated and air-tight envelopes. This exposes vulnerable communities to increases mortality risks that is bound to only get worse with an ever-worsening climate warming. Moreover, heatwaves are often accompanied by other unexpected extreme events or "shocks" such as power outages, which can render some buildings unhabitable even long after these shocks are over. Thus, it is critical to design future-proof buildings and systems. This performance characteristic of a building is known as resilience to overheating. Currently, in practice, designers and architects are under-equipped to deal with such events due to a lack of knowledge on resilience performance characteristics and building design parameters that influence them. There is a lack of a framework in current building standards to consider resilience and shock events in the design stage of a building. This includes the lack of straightforward and "easy-to-communicate" resilience key performance indicators. By bringing together academic and industrial partners, the VLAIO ICON project ReCOver++ aims to bridge this knowledge gap and make resilience a more actionable concept for architects, engineering companies and manufacturers. ReCOver++ defines a new holistic resilience indicator relating resilience performance characteristics to the building and systems' most influential parameters which aims to improve resilience to overheating. This session aims to communicate the results of the ReCOver++ project by presenting this novel indicator and discusses the implications of its use in practice.

KEYWORDS

Thermal resilience, climate change, heatwaves, buildings, performance indicators

1 RESEARCH METHODOLOGY

The work plan of ReCOver++ consists of 5 interacting work packages (WP) as seen in Figure 1 that aim to demonstrate the resilience indicators on real-use case study buildings. In WP1, the shocks that can cause overheating were defined, classified and quantified and each of the project partners selected representative case studies of different building typologies and HVAC systems. The selected case studies were an array of highly insulated and airtight residential and non-residential buildings equipped with different solar shading strategies and ventilative cooling technologies with different types of smart control. Note that WP1 eventually focused on heatwaves (HWs) as they were shown to challenge resilience at a higher level than system shocks (Sengupta, 2023). The HWs occurring during historical (2001-2020) and midterm future (2041-2060) were chosen. Future long-term (2081-2100) were not considered since it was assumed that by that time frame, building standards would be updated rendering current case study buildings non representative. HW weather data files were determined using the methodology of IEA EBC's Annex 80 (Machard, 2024) using bias corrected CORDEX data and extracted according to the methodology of (Ouzeau, 2016), where regional temperature HW thresholds were defined.

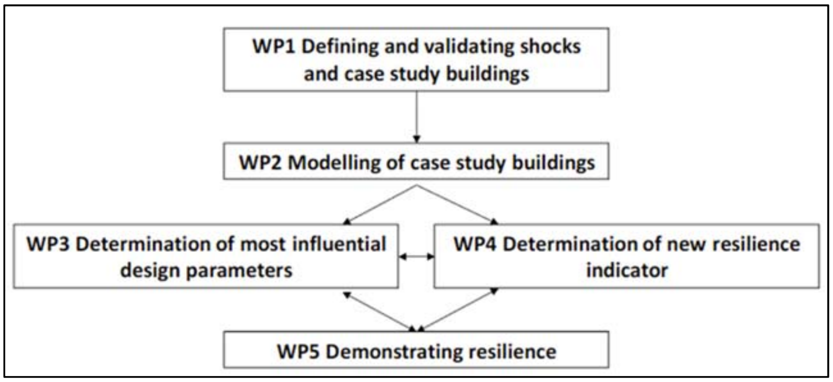

Figure 1. ReCOver++ workflow overview

In WP2, the partners developed models of their case study buildings using various modelling tools such as Dymola (Modelica language), EnergyPlus and IDA-ICE. The partners verified the output comparativeness of the different tools by modelling and simulating a common building during a HW event. The case studies used by the partners were partially or fully validated against experimental data. In WP3, thermal resilience aspects (absorptive, adaptability and recovery capacities) were determined as representative aspects of the resilience response of a building. The Standard effective Temperature (SET) (based on the 2-node thermoregulation model of Gagge, 1972) degree.hours above 28°C was selected as an indicator that quantifies the degree of impact while integrating all three resilience aspects simultaneously. Subsequently, parametric studies were conducted under different HW events and different scenarios of building design and HVAC systems. The scenarios included the baseline case and variations of it. The outputs from simulations were used to calculate the SET degree.hours. WP4 was conducted in parallel to WP3 where KU Leuven & Ghent University conducted sensitivity analysis on reference apartment, educational and office buildings to determine via regression analysis a mathematical relation linking the SET degree.hours to the building's most influential parameters. WP4 showed that buildings' 4 most influential parameters were (by order of magnitude) the window to wall ratio, the cooling capacity and the operation of natural ventilation and solar shading. The validity of the indicator was verified based on the parametric study results from WP3. From insights gained from WP3 and 4, WP5 aimed to formulate best practices of resilient designs and strategies. For example, the architectural partners (i.e., archipelago) found that reducing the glazing ratio, providing shading, and adopting ventilative cooling strategies, with or without thermal mass, appear to be relevant strategies to reduce the energy demand for cooling, both under current and future typical meteorological year, and to improve the resilience to overheating.

2 REFERENCES

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