Thermal Resilience of Social Housing in Bolzano: A Microclimate-Informed Simulation Approach

Sana Fatima Ali [(1)] - Yi Chen [(1)] - Akshit Gupta [(1)] - Annamaria Belleri [(1)] - Rocco Pace [(1)] - Giulia Paoletti [(1)] - Roberto Lollini [(1)]

[(1)] Eurac Research, Institute For Renewable Energy, Bolzano, Italy

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Abstract Climate extremes, such as heatwaves, are becoming more frequent and severe, directly impacting how people live in cities and buildings. Building energy simulations (BES) typically rely on typical meteorological year dataset for outdoor boundary conditions, which overlook localized urban climate effects, leading to underestimated overheating risk of indoor environments. This study presents a multi-scale simulation framework to assess the thermal resilience of a typical social housing apartment in Bolzano, Italy, by integrating urban microclimate modelling with BES under both current and future climate conditions.

The approach involves generating microclimate-adjusted weather files using ENVI-met for two urban configurations: one with minimal vegetation and one incorporating enhanced vegetative cover. These are compared with both present-day and future weather scenarios to evaluate the combined effects of urban greening and climate change on the evaluation of indoor thermal conditions. The building model, developed in EnergyPlus via Rhino–Grasshopper with Ladybug and Honeybee plugins, represents one of the apartments within the Casette Inglesi neighbourhood of Bolzano and is calibrated against monitored indoor temperatures over a 3 week period in August 2024.

Simulations across all scenarios assess key performance indicators under extreme heat events. Preliminary results reveal substantial differences in predicted indoor conditions when using microclimate-informed inputs, particularly in scenarios with urban greening.

This study emphasizes the importance of high-resolution, context-specific weather data in evaluating thermal resilience of buildings. By isolating the effect of urban vegetation on building performance, the framework highlights the risk of oversimplification in conventional BES workflows. The results lay the groundwork for a more comprehensive assessment of heat mitigation strategies in future work, supporting informed urban and building adaptation planning under climate stress.